PALÆONTOGRAPHICAL SOCIETY.
VOL. LXV.

THE PLEISTOCENE MAMMALIA.

MUSTELIDÆ.

WITH TITLE-PAGE AND INDEX TO VOL. II.

PAGES 1—28; PLATES I—VIII.

GANOID FISHES OF BRITISH CARBONIFEROUS FORMATIONS.

PALÆONISCIDÆ.

PART I, NO. 6.

PAGES 159—180; PLATES XXXVI—XL.

THE FISHES OF THE ENGLISH CHALK.

PART VII.

INCLUDING TITLE-PAGE AND INDEX.

PAGES i—viii, 225—264; PLATES XLVII—LIV.

THE CRETACEOUS LAMELLIBRANCHIA.

VOL. II, PART VIII.

PAGES 285—340; PLATES LI—LIV.

THE FOSSIL SPONGES.

TITLE-PAGE AND INDEX TO VOL. I.

PAGES 255—264.

ISSUED FOR 1911.

PALÆONTOGRAPHICAL SOCIETY.

VOLUME LXV.

CONTAINING

1. THE PLEISTOCENE MAMMALIA.—MUSTELIDÆ. With Title-page and Index to Vol. II. By Prof. S. H. REYNOLDS. Eight Plates.

2. THE CARBONIFEROUS GANOID FISHES. Part I, No. 6. By Dr. R. H. TRAQUAIR. Five Plates.

3. THE FISHES OF THE ENGLISH CHALK. Part VII. With Title-page and Index. By Dr. A. S. WOODWARD. Eight Plates.

4. THE CRETACEOUS LAMELLIBRANCHIA. Vol. II, Part VIII. By Mr. H. WOODS. Four Plates.

5. THE FOSSIL SPONGES. Title-page and Index to Vol. I. By Dr. G. J. HINDE.

ISSUED FOR 1911.

LONDON:
PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

AGENTS FOR THE SOCIETY:
DULAU AND CO., LTD., 37, SOHO SQUARE, W.

FEBRUARY, 1912.

THE PALÆONTOGRAPHICAL SOCIETY was established in the year 1847, for the purpose of figuring and describing British Fossils.

Each person subscribing ONE GUINEA *is considered a Member of the Society, and is entitled to the Volume issued for the Year to which the Subscription relates. The price of the Volume to Non-subscribers is* TWENTY-FIVE SHILLINGS NET.

Subscriptions are considered to be due on the 1st of January in each year.

The Annual Volumes are now issued in *two forms of Binding:* 1st, with all the Monographs stitched together and enclosed in one cover; 2nd, with each of the Monographs in a paper cover, and the whole of the separate parts enclosed in an envelope. Members wishing to obtain the Volume arranged in the LATTER FORM are requested to communicate with the Secretary.

Most of the *back volumes* are in stock. Monographs or parts of Monographs already published can be obtained, apart from the annual volumes, from Messrs. DULAU AND CO., LTD., 37, Soho Square, London, W., who will forward a complete price list on application.

Members desirous of forwarding the objects of the Society can be provided with plates and circulars for distribution on application to the Secretary, Dr. A. SMITH WOODWARD, British Museum (Nat. Hist.), South Kensington, London, S.W.

The following Monographs are in course of publication :

The Fossil Sponges, by Dr. G. J. Hinde.

The Graptolites, by Prof. Lapworth, Miss Elles, and Miss Wood.

The Cambrian Trilobites, by Mr. Philip Lake.

The Cretaceous Lamellibranchia, by Mr. H. Woods.

The Palæoniscid Fishes of the Carboniferous Formation, and the Fishes of the Old Red Sandstone, by Dr. R. H. Traquair.

The Pleistocene Mammalia, by Prof. S. H. Reynolds.

ANNUAL REPORT

OF THE

PALÆONTOGRAPHICAL SOCIETY, 1911,

WITH

LIST

OF

The Council, Secretaries, and Members

AND

A LIST OF THE CONTENTS OF THE VOLUMES ALREADY PUBLISHED.

Council and Officers elected March, 1911.

President.

HENRY WOODWARD, Esq., LL.D., F.R.S., F.G.S.

Vice-Presidents.

Rev. Canon Bonney, D.Sc., F.R.S.
Sir Archibald Geikie, K.C.B., P.R.S.
G. J. Hinde, Esq., Ph.D., F.R.S.
E. T. Newton, Esq., F.R.S.

Council.

H. A. Allen, Esq., F.G.S.
F. A. Bather, Esq., M.A., D.Sc., F.R.S.
Rev. R. Ashington Bullen, B.A., F.G.S.
H. Dewey, Esq., F.G.S.
Upfield Green, Esq., F.G.S.
William Hill, Esq., F.G.S.
John Hopkinson, Esq., F.L.S., F.G.S.
Miss M. S. Johnston.
F. L. Kitchin, Esq., M.A., Ph.D., F.G.S.
Mrs. G. B. Longstaff.
A. W. Oke, Esq., LL.M., F.G.S.
F. R. Cowper Reed, Esq., M.A., F.G.S.
Dr. Arthur W. Rowe, F.G.S.
A. Strahan, Esq., D.Sc., F.R.S.
Henry Woods, Esq., M.A., F.G.S.
G. W. Young, Esq., F.G.S.

Treasurer.

G. J. Hinde, Esq., Ph.D., F.R.S., F.G.S.

Secretary.

A. Smith Woodward, Esq., LL.D., F.R.S., British Museum (Nat. Hist.), South Kensington, London. S.W.

Local Secretaries.

Bath—Rev. H. H. Winwood, M.A., F.G.S.
Berlin—Messrs. Friedländer & Son.
Cambridge—H. Woods, Esq., M.A., F.G.S.
Cheltenham—L. Richardson, Esq., F.G.S.
Hertfordshire—J. Hopkinson, Esq., F.G.S.
Oxford—Prof. W. J. Sollas, F.R.S.
Staffordshire—Dr. Wheelton Hind, F.G.S.

ANNUAL REPORT OF THE COUNCIL

FOR THE YEAR ENDING 31ST DECEMBER, 1910.

READ AND ADOPTED AT THE

ANNUAL GENERAL MEETING,

HELD AT THE APARTMENTS OF THE GEOLOGICAL SOCIETY, BURLINGTON HOUSE, 24TH MARCH, 1911.

DR. HENRY WOODWARD, F.R.S., PRESIDENT,

IN THE CHAIR.

THE Council, in presenting their Sixty-fourth Annual Report, have pleasure in recording another year's successful work. The volume for 1910 comprises instalments of the monographs of "Carboniferous Ganoid Fishes," by Dr. Traquair; "English Chalk Fishes," by Dr. A. S. Woodward; "Cretaceous Lamellibranchia," by Mr. H. Woods; and "British Graptolites," by Miss Elles and Miss Wood (Mrs. Shakespear). It also includes a small complete monograph of "British Carboniferous Arachnida," by Mr. R. I. Pocock, which the Council think will prove acceptable as a valuable contribution to our knowledge of these rare fossils. All the large monographs of which parts are included in this volume, are now approaching completion, and the Council hope soon to begin the publication of other works which have been in preparation for some time.

Owing to unforeseen delay in the completion of some of the contributions, the volume for 1910 was not issued until the end of January, 1911, and as a consequence the expense of binding and some of the printing (amounting to about £100) could not be included in the balance-sheet for the year, which, as usual, has been brought down to the end of December. The total expenditure on the volume, however, as now ascertained, only slightly exceeds the actual income, though it

must be added that this result is due to the generosity of the Carnegie Trust for the Universities of Scotland, which gave to the Society the five plates illustrating Carboniferous Fishes, and to the gratuitous services of Mrs. Shakespear, who prepared all the original drawings for the text-figures of Graptolites.

The Council are still much concerned about the difficulty of obtaining new personal subscribers to replace the losses sustained each year, and have published various advertisements without much success. They would welcome the help and personal influence of the members in making the work and needs of the Society more widely known among those who are interested in the study of fossils.

Among losses during the past year the Society mourns the death of a distinguished conchologist, the Rev. R. Boog Watson, F.R.S.E.

The thanks of the Society are due to the Council of the Geological Society for permission both to store the stock of back volumes, and to hold the Council Meetings and the Annual General Meeting in their apartments.

In conclusion, it is proposed that the retiring members of Council be Prof. Garwood, Mr. Lang, Mr. Clement Reid, and Prof. Watts; that the new members be Mr. H. Dewey, Mr. Upfield Green, Dr. Rowe, and Dr. Strahan; that the President be Dr. Henry Woodward; the Treasurer, Dr. G. J. Hinde; and the Secretary, Dr. A. Smith Woodward.

Annexed is the Balance-sheet.

The PALÆONTOGRAPHICAL SOCIETY in account with Dr. GEORGE J. HINDE, F.R.S., Treasurer.

Cr. — *From January* 1*st*, 1910, *to December* 31*st*, 1910. — *Dr.*

		£ s. d.	£ s. d.
Balance from last Account			335 16 2
Members' Subscriptions—1908–1909	55	57 15 0	
,, ,, 1910	276	289 16 0	
,, ,, 1911	2	2 2 0	349 13 0
	333		
Carriage paid by Members			1 15 0
Sales of back stock to Members			47 1 7
Sales by Messrs. Dulau & Co., Ltd.			79 14 6
Repaid Income Tax (1 year)			0 17 6
Dividends on £500 Natal 3 per cent. Stock (less income tax)			14 2 6
Interest on Deposit			8 7 7
			£837 7 10

	£ s. d.	£ s. d.
Letterpress printing, Vol. LXIV	81 18 10	
Paper	14 3 6	96 2 4
Drawing text-figures and making blocks	40 13 0	
Drawing plates	98 11 0	
Collotype and lithographic printing	87 11 2	
Rental and proving lithographic stones	2 15 0	229 10 2
Packing and distribution, Vol. LXIII		16 11 1
Secretary's honorarium		52 10 0
Postage and stationery		6 2 7
Revising and rearranging Stock		6 6 0
Packing paper for Stock		1 3 0
Advertising		4 18 0
Fire Insurance		0 15 0
Petty charges		0 18 6
Balance at Bank—Current Account £45 13*s*. 2*d*. *minus* cheque not presented £25 4*s*. 0*d*.	20 9 2	
Balance at Bank—Deposit Account	400 0 0	420 9 2
Cash in hand		2 2 0
		£837 7 10

We have examined the above account, compared it with the vouchers, and find it to be correct; we have also seen the receipt for £500 Natal 3 per cent. Consolidated Stock.

Chas. W. Andrews.
W. P. D. Stebbing.
E. T. Newton.
Alfred W. Oke.
} Auditors.

March 6th, 1911.

Owing to delay in completion of the Annual Volume, the above statement does not include all liabilities for the year 1910.

LIST OF MEMBERS.*

CORRECTED TO 1st NOVEMBER, 1911.

Aberdeen, University Library.
Adelaide (Australia) Public Library.
Adlard, R. E., Esq., Bartholomew Close. E.C.
Allen, Messrs. E. G. & Son, King Edward Mansions, 14, Grape Street, Shaftesbury Avenue. W.C.
Allen, H. A., Esq., F.G.S., 28, Jermyn Street. S.W.
Amherst College, Mass., U.S.A.
Amsterdam, Royal Academy of Sciences.
Anderson, Tempest, Esq., M.D., F.G.S., 17, Stonegate, York.
Andrews, C. W., Esq., D.Sc., F.R.S., British Museum (Nat. Hist.), South Kensington. S.W.
Arlecdon and Frizington Public Library, Frizington, Cumberland.
Asher and Co., Messrs., 13, Bedford Street, Covent Garden. W.C.
Avebury, Right Hon. Lord, F.R.S., 15, Lombard Street. E.C.

Bâle (Switzerland), University Library.
Balston, W. E., Esq., F.G.S., Barvin, Potter's Bar.
Banks, W. H., Esq., Hergest Croft, Kington, Herefordshire.
Barclay, F. H., Esq., F.G.S., The Warren, Cromer, Norfolk.
Barnes, J., Esq., F.G.S., South Cliff House, Higher Broughton, Manchester.
Barrow, George, Esq., F.G.S., 28, Jermyn Street. S.W.
Bath, Royal Literary and Scientific Institution.
Bather, F. A., Esq., M.A., D.Sc., F.R.S., British Museum (Nat. Hist.). S.W.
Battersea Public Library, Lavender Hill. S.W.
Bedford, His Grace the Duke of, K.G., F.R.S., Woburn Abbey, Bedfordshire.
Bedford Literary Institute, Bedford.
Belfast Linen Hall Library, Donegal Square North, Belfast.
Belfast, Queen's University.
Bell, W. Heward, Esq., F.G.S., Cleeve House, Seend, Melksham.
Bergen (Norway), Museums Bibliothek.
Birkenhead Public Library, Birkenhead.

* Members are requested to inform the Secretary of any errors or omissions in this list, and of any delay in the transmission of the Yearly Volumes.

Birmingham Free Public Library, Ratcliff Place, Birmingham.
Birmingham Library, Margaret Street, Birmingham.
Birmingham University Library.
Blackburn Public Library, Blackburn.
Blackmore, Humphrey P., Esq., M.D., F.G.S., Salisbury.
Blathwayt, Lieut.-Col. Linley, Eagle House, Batheaston, Bath.
Blundell, Harold, Esq., Fairlawn, Harpenden, Herts.
Bolton, Chadwick Museum.
Bonn (Germany), Geological-Palæontological Institute of the University.
Bonney, Rev. Canon T. G., D.Sc., F.R.S., *Vice-President*, 9, Scroope Terrace, Cambridge.
Bootle-cum-Linacre Public Library, Bootle, Liverpool.
Bordeaux, University Library.
Boston Society of Natural History, Boston, Mass., U.S.A.
Boston Public Library, Boston, Mass., U.S.A.
Boulogne-sur-Mer (France), Bibliothèque Communale.
Bournemouth Natural Science Society.
Bradley, F. L., Esq., F.G.S., Ingleside, Malvern Wells.
Brighton and Hove Natural History Society, Brighton.
Bristol Naturalists' Society, Geological Section, *per* B. A. Baker, Esq., Henbury House, Henbury, near Bristol.
Bristol Central Public Library.
Bristol Museum of Natural History, Queen's Road, Bristol.
Bristol University Library.
Bromley Naturalists' Society, 92, London Road, Bromley, Kent.
Brown, Alexander Oestrand, Esq., B.A., F.G.S., 4, The Grove, Highgate. N.
Brydone, R. M., Esq., F.G.S., The Stock Exchange, London.
Buchan-Hepburn, Sir Archibald, Bart., Smeaton-Hepburn, Preston Kirk, East Lothian. N.B.
Bullen, Rev. R. Ashington, B.A., F.G.S., Hilden Manor, Tonbridge, Kent.
Burr, Malcolm, Esq., D.Sc., F.L.S., F.G.S., Eastry, Kent.
Burrows, Henry W., Esq., F.G.S., 17, Victoria Street. S.W.
Burslem Public Library, Burslem.
Buxton Public Library, Town Hall, Buxton.

Calcutta, Geological Survey of India.
Cambridge Philosophical Society's Library, New Museums, Cambridge.
Cambridge, St. John's College.
Cambridge, Sidney Sussex College.
Cambridge, Trinity College.
Cambridge, University Library.
Cambridge, Sedgwick Museum.
Canadian Geological Survey, Sussex Street, Ottawa, Canada.
Capetown Geological Commission, South African Museum.
Cardiff Public Library, Cardiff.
Cardiff, University College of South Wales and Monmouthshire.
Carlisle Public Library, Carlisle.
Carruthers, R. G., Esq., 33, George Square, Edinburgh.
Chelsea Public Library, Manresa Road. S.W.
Cheltenham College, Cheltenham.

Cheltenham Natural Science Society, Cheltenham.
Chester Society of Natural Science, Chester.
Chicago (U.S.A.), Newberry Library.
Chicago (U.S.A.) Public Library.
Chicago (U.S.A.), University Library.
Chiswick Public Library, Chiswick. W.
Christiania (Norway), University Library.
Cincinnati (U.S.A.) Public Library.
Clarke, Mrs. Stephenson, Brook House, Haywards Heath, Sussex.
Clermont-Ferrand (France), University Library.
Clifton College, Clifton, Bristol.
Clough, C. T., Esq., F.G.S., 28, Jermyn Street. S.W.
Cobbold, E. S., Esq., F.G.S., All Stretton, Church Stretton, R.S.O., Shropshire.
Codd, J. Alfred, Esq., F.G.S., 7, Tettenhall Road, Wolverhampton.
Coombs, J. Ashton, Esq., F.G.S., Albion Lodge, Gloucester Road, Cheltenham.
Cooper, C. Forster, Esq., M.A., 14, Orsett Terrace, Hyde Park. W.
Cornell University, Ithaca, U.S.A.
Coventry Free Public Library, Coventry.
Crosfield, Miss Margaret, Undercroft, Reigate.
Crosse, Miss, The Yew House, Caterham Valley, Surrey.
Croydon Central Public Library, Town Hall, Croydon.

Darwin, W. E., Esq., F.G.S., 11, Egerton Place. S.W.
Dawkins, Prof. W. Boyd, D.Sc., F.R.S., F.G.S., Fallowfield House, Fallowfield, Manchester.
Dawson, Messrs. W., and Sons, St. Dunstan's House, Fetter Lane. E.C.
Deane, Henry, Esq., F.L.S., Commercial Bank Chambers, George and Margaret Streets, Sydney. N.S.W.
Derby Free Library and Museum, Derby.
Devonport Free Public Library, Devonport.
Devonshire, His Grace the Duke of, Chatsworth House, Derbyshire.
Dewey, Henry, Esq., F.G.S., 28, Jermyn Street. S.W.
Dijon (France), University Library.
Dixon, E., Esq., B.Sc., F.G.S., 28, Jermyn Street. S.W.
Dorset County Museum Library, Dorchester.
Drake, Henry C., Esq., F.G.S., 30, Highfield, Scarborough.
Drew, Dr. J., F.G.S., Montrose, Battledown, Cheltenham.
Dublin, National Library.
Dublin, Royal College of Science for Ireland, Stephen's Green.
Dublin, Royal Irish Academy, 19, Dawson Street.
Dublin, Trinity College.
Ducie, Right Hon. Earl of, F.R.S., Tortworth Court, Gloucestershire.
Dundee Free Library, Dundee.
Durham, the Dean and Chapter of (by C. Rowlandson, Esq., The College, Durham).

Edinburgh Geological Society, India Buildings, George IV Bridge, Edinburgh.
Edinburgh, Royal Scottish Museum, Argyle Square, Edinburgh.
Edinburgh Public Library, Edinburgh.

Edinburgh, Royal Society.
Edinburgh, University Library.
Epsom College, Epsom.
Erlangen (Germany), Mineralogical-Geological Institute of the University.
Eton College, Windsor, *per* M. D. Hill, Esq., M.A.
Exeter, Royal Albert Memorial Public Library, Queen Street.

Fleure, Prof. H. J., D.Sc., University College, Aberystwyth.
Folkestone Public Library and Museum, Folkestone.
Foulerton, Dr. J., 44, Pembridge Villas, Bayswater. W.
Friedländer, Messrs., *Local Secretaries*, 11, Carlstrasse, Berlin.
Fuller, Rev. A., M.A., The Lodge, 7, Sydenham Hill. S.E.

Galashiels, N.B., Public Library.
Galway, University College.
Garwood, Prof. E. J., M.A., F.G.S., University College, Gower Street. W.C.
Gateshead-on-Tyne Public Library, Gateshead-on-Tyne.
Geikie, Sir Archibald, K.C.B., LL.D., Pres.R.S., *Vice-President*, Shepherd's Down, Haslemere, Surrey.
Gibson, Miss, Hill House, Saffron Walden.
Gibson, Walcot, Esq., D.Sc., F.G.S., 10, Kingdon Road, W. Hampstead. N.W.
Gilmour, M., Esq., F.Z.S., Saffronhall House, 1, Windmill Road, Hamilton. N.B.
Glasgow, Geological Society, 150, Hope Street.
Glasgow, Mitchell Library, 21, Miller Street.
Glasgow, Royal Philosophical Society, 207, Bath Street.
Glasgow, Kelvingrove Museum.
Glasgow, University Library.
Gloucester Free Public Library.
Gotha (Germany), Herzogliche Bibliothek.
Great Yarmouth Public Library.
Green, Upfield, Esq., F.G.S., 8, Bramshill Road, Harlesden. N.W.
Greenly, Edward, Esq., F.G.S., Achnashean, near Bangor.
Gregory, Prof. J. W., D.Sc., F.R.S., The University, Glasgow.

Haileybury College, near Hertford.
Halifax Free Public Library, Halifax.
Halle (Germany), University Library.
Hammersmith Carnegie (Central) Library, Hammersmith. W.
Hampstead Public Library, Finchley Road, Hampstead. N.W.
Harker, Alfred, Esq., M.A., F.R.S., St. John's College, Cambridge.
Harley, Dr. John, F.L.S., Beedings, Pulborough, Sussex.
Harmer, F. W., Esq., F.G.S., Oakland House, Cringleford, near Norwich.
Hastings Public Library.
Hawick Public Library, Hawick. N.B.
Heidelberg (Germany), University Library.

Hill, Rev. Edwin, M.A., F.G.S., The Rectory, Cockfield, Bury St. Edmunds.
Hill, Wm., Esq., F.G.S., The Maples, Hitchin.
Hind, Wheelton, Esq., M.D.Lond., F.R.C.S., F.G.S., *Local Secretary*, Roxeth House, Stoke-on-Trent.
Hinde, Geo. J., Esq., Ph.D., F.R.S., *Treasurer* and *Vice-President*, 24, Avondale Road, South Croydon.
Hodges, Isaac, Esq., F.G.S., Eshald House, Woodlesford, near Leeds.
Hodges, Figgis, and Co., 104, Grafton Street, Dublin.
Holcroft, Sir Charles, The Shrubbery, Summerhill, Kingswinford, near Dudley.
Hooley, R. W., Esq., F.G.S., Earlescroft, St. Giles' Hill, Winchester.
Hopkinson, John, Esq., F.L.S., F.G.S., *Local Secretary*, Weetwood, Watford.
Hove Public Library, Hove, Brighton.
Howse, Sir Henry G., M.S., F.R.C.S., The Tower House, Cudham, near Sevenoaks, Kent.
Hughes, Prof. T. M'Kenny, M.A., F.R.S., Sedgwick Museum, Cambridge.
Hull Public Library, Hull.
Hutchinson, Rev. H. N., F.G.S., 17, St. John's Wood Park, Finchley Road. N.W.
Hutton, Miss Mary, Putney Park, Putney Park Lane. S.W.

Ipswich Museum, Ipswich. (F. Woolnough, Esq., Secretary.)
Isle of Man Natural History Society, Ramsey, Isle of Man.

Johnes, Lady E. Hills, Dolau Cothy, Llandeilo, R.S.O., South Wales.
Johns Hopkins University, Baltimore, U.S.A.
Johnson, E., Esq., 6°, Bickenhall Mansions, Gloucester Place. W.
Johnston, Miss Mary S., Hazlewood, Wimbledon Hill. S.W.
Jukes-Browne, A. J., Esq., B.A., F.R.S, F.G.S., Westleigh, Torquay.

Kettering Public Library, Kettering.
Kilmarnock Public Library, Kilmarnock. N.B.
Kirkcaldy Naturalists' Society; John G. Low, Esq., 228, High Street, Kirkcaldy. N.B.
Kitchin, F. L., Esq., M.A., Ph.D., F.G.S., Geol. Survey of England, 28, Jermyn Street. S.W.
Knipe, H. R., Esq., F.L.S., 9, Linden Park, Tunbridge Wells.

Lake, P., Esq., M.A., F.G.S., St. John's College, Cambridge.
Lancaster Public Library, Lancaster.
Lang, W. D., Esq., M.A., F.G.S., British Museum (Nat. Hist.), South Kensington. S.W.
Lapworth, Prof. Charles, LL.D., F.R.S., University of Birmingham.
Lausanne (Switzerland) Cantonal Library.
Leeds Philosophical and Literary Society, Leeds.
Leeds Public Library, Leeds.
Leeds, University Library.
Leek, Staffordshire, Nicholson Institute.
Leicester Town Museum, Leicester.
Leipzig (Germany), University Library.

Leyton Public Library, Leyton. N.E.
Liège (Belgium), Geological Laboratory of the University.
Lille (France), Geological Laboratory of the University, 159, Rue Brûle-Maison.
Lisbon, Geological Survey of Portugal.
Lissajous, Mons. M., 10, Quai des Marans, Mâcon, France.
Liveing, Professor G. D., M.A., F.R.S., Cambridge.
Liverpool, Athenæum Library.
Liverpool, Free Public Library.
Liverpool, Geological Society of.
London, Board of Education, Science Library, South Kensington. S.W.
London, British Museum, Bloomsbury. W.C.
London, British Museum (Nat. Hist.), Cromwell Road. S.W.
London, Corporation of, Library Committee of, Guildhall. E.C.
London, Geological Society, Burlington House. W.
London Institution, Finsbury Circus. E.C.
London, King's College, Strand. W.C.
London, Linnean Society, Burlington House, Piccadilly. W.
London, Museum of Practical Geology, Jermyn Street. S.W.
London, Royal College of Surgeons, Lincoln's Inn Fields. W.C.
London, Royal Institution of Great Britain, Albemarle Street. W.
London, Royal Society of, Burlington House. W.
London, St. Martin's-in-the-Fields Public Library, 115, St. Martin's Lane, W.C.
London, Surveyors' Institution, 12, Great George Street, Westminster. S.W.
London, University College, Gower Street. W.C.
London, Zoological Society, Regent's Park. N.W.
Longstaff, Mrs., Highlands, Putney Heath. S.W.
Lydekker, Richard, Esq., F.R.S., The Lodge, Harpenden, Herts.

Mackenzie, G. W., Esq., 13, William Street, Lowndes Square. S.W.
McNeill, Bedford, Esq., F.G.S., 29, North Villas, Camden Square. N.W.
Madras Government Museum, *per* Messrs. Baker and Co., 6, Bond Court, Walbrook. E.C.
Maidstone Museum, *per* Brenchley Trustees, Maidstone.
Malton Field Naturalists' and Scientific Society, Malton, Yorkshire.
Manchester Free Library.
Manchester, Geological Society of, 5, John Dalton Street, Manchester.
Manchester Literary and Philosophical Society, 36, George Street, Manchester.
Marburg (Germany), University of.
Marr, J. E., Esq., M.A., Sc.D., F.R.S., St. John's College, Cambridge.
Melbourne Public Library.
Mennell, H. T., Esq., F.L.S., The Red House, Croydon.
Metcalfe, Henry F., Esq., Cyprus House, Exmouth.
Middlesbrough Free Library.
Middleton Free Public Library, Middleton, near Manchester.
Milan (Italy), Societa Italiana di Scienze Naturali, Palazzo del Museo Civico.
Mitchinson, Rt. Rev. J., D.C.L., D.D., Canon of Gloucester and Master of Pembroke College, Oxford.
Mond, Robert, Esq., M.A., F.R.S.E., F.G.S., The Elms, Avenue Road, St. John's Wood. N.W.

Munich (Germany), Alte Akademie, Geologisches Museum.
Munich Royal Library.

Nantwich Public Library.
Neumeyer, Dr. Max, Halle-a.-d.-Saale (Germany).
New South Wales, Royal Society of, Sydney.
New York (U.S.A.) Public Library.
Newcastle-on-Tyne, Armstrong College.
Newcastle-on-Tyne, Literary and Philosophical Society of, Westgate Street, Newcastle-on-Tyne.
Newcastle-on-Tyne Public Library.
Newington Public Library, Walworth Road. S.E.
Newport Free Library, Newport, Monmouthshire.
Newton, E. T., Esq., F.R.S., *Vice-President*, Florence House, Willow Bridge Road, Canonbury. N.
Noble, Arthur H., Esq., 28, Jermyn Street. S.W.
North Devon Athenæum, Barnstaple.
North Staffordshire Field Club, Stoke, Staffordshire.
Northampton Natural History Society, Northampton.
Northumberland, His Grace the Duke of, K.G., F.R.S., Alnwick Castle.
Norwich Free Library.
Norwich, Norfolk and Norwich Library.
Nottingham Free Library.

Oke, Alfred W., Esq., F.G.S., 32, Denmark Villas, Hove, Sussex.
Oldham Free Public Library.
Oswestry Free Public Library.
Oxford, Bodleian Library.
Oxford, Radcliffe Library.

Paisley Philosophical Institution.
Paris, École des Mines.
Paris, Geological Society of France, 7, Rue des Grands Augustins.
Paris, Muséum National d'Histoire Naturelle, Laboratoire de Paléontologie.
Paris, Sorbonne, Laboratoire de Géologie.
Part, G. M., Esq., Hotel Metropole, Folkestone.
Peabody Institute, Salem, Mass., U.S.A.
Penzance, Royal Geological Society of Cornwall.
Peterborough Natural History, Scientific, and Archæological Society.
Philadelphia (U.S.A.), Academy of Natural Sciences.
Pittsburgh (U.S.A.), Carnegie Museum.
Plymouth Free Public Library.
Plymouth Institution, Library of, Athenæum, Plymouth.
Poole Free Library.
Portis, Dr. A., Professor of Geology, The University, Rome.
Portsmouth Free Public Library.
Power, Edward John, Esq., F.G.S., 25, Ashburn Place, South Kensington. S.W.

Prague (Bohemia), Royal Geological Institution of the German Carl Ferdinand University.
Preston Free Public Library.
Pryor, M. R., Esq., Weston Manor, Stevenage, Herts.

Queensland Museum, Brisbane.

Rastall, R. H., Esq., M.A., F.G.S., Christ's College, Cambridge.
Reading Public Library and Museum (W. H. Greenhough, Librarian), Reading.
Reed, F. R. Cowper, Esq., M.A., F.G.S., Gaultier, Madingley Road, Cambridge.
Reid, Clement, Esq., F.R.S., One Acre, Milford-on-Sea, Hants.
Rennes (France), University Library.
Reynolds, Prof. S. H., M.A., F.G.S., University, Bristol.
Richardson, L., Esq., F.G.S., *Local Secretary*, 10, Oxford Parade, Cheltenham.
Rochdale Free Public Library.
Rowe, A. W., Esq., M.S., M.B., F.G.S., Shottendane, Margate.
Rudler, F. W., Esq., I.S.O., F.G.S., Ethel Villa, Tatsfield, Westerham, Kent.
Rugby School Natural History Society.

Salfeld, Dr. Hans, Geological Institute of University, Göttingen, Germany.
St. Andrews, University Library.
St. Helens Free Public Library, The Gamble Institute, St. Helens.
Salford Borough Royal Museum and Library, Peel Park, Manchester.
Salisbury Free Library.
Scarborough Philosophical Society.
Scharff, R. F., Esq., Ph.D., National Museum, Dublin.
Schmidt, Dr. Martin, Büchsenstrasse 56, Stuttgart.
Scott, D. H., Esq., M.A., Ph.D., F.R.S., East Oakley House, Oakley, Hants.
Sheffield Free Public Library.
Sheffield, Literary and Philosophical Society of, Church Street.
Sheffield, Weston Park Public Museum.
Sheppard, Thomas, Esq., F.G.S., Municipal Museum, Hull.
Sherborne, King's School, Library of.
Shrewsbury Free Public Library.
Simpson, Rev. A., B.A., B.Sc., F.G.S., 28, Myrtle Park, Crosshill, Glasgow.
Smith, Mrs. Emma, Hencotes House, Hexham.
Sollas, Professor W. J., D.Sc., F.R.S., *Local Secretary*, 173, Woodstock Road, Oxford.
Somersetshire Archæological and Natural History Society, Museum, Taunton.
Sophia, University of.
South Shields Free Public Library.
Southport Free Public Library.
Spencer, W. K., Esq., M.A., 19, Avondale Road, South Croydon.
Stebbing, W. P. D., Esq., F.G.S., 78A, Lexham Gardens, Kensington. W.
Stechert, G. E., Esq., 2, Star Yard, Carey Street, Chancery Lane. W.C.
Stepney Borough Reference Library, Bancroft Road, Mile End Road. E.
Stockholm, Royal Swedish Academy of Sciences.
Stoke Newington Public Library, Church Street, Stoke Newington. N.

Stoke-upon-Trent Free Library, Stoke-upon-Trent.
Stonyhurst College, Blackburn.
Storey, Charles B. C., Esq., M.A., F.G.S., 24a, Portland Place. W.
Strahan, A., Esq., M.A., Sc.D., F.R.S., Geological Survey, 28, Jermyn Street. S.W.
Sunderland Corporation Museum.
Sunderland Subscription Library, Fawcett Street, Sunderland.
Sutcliffe, W. H., Esq., F.G.S., Shore Mills, Littleborough, Lancashire.
Swansea Public Library.
Swansea, Royal Institution of South Wales.
Sydney, New South Wales, University of.
Sydney, New South Wales, Australian Museum.

Tasmania, Royal Society of.
Toronto (Canada), University Library.
Torquay Natural History Society, Museum, Babbacombe Road, Torquay.
Toulouse (France), University Library.
Trafford, H. H., Esq., The Bungalow, Croston, near Preston.
Traquair, R. H., Esq., M.D., LL.D., F.R.S., The Bush, Colinton, Midlothian.
Treacher, Llewellyn, Esq., F.G.S., Somercroft, Twyford, Berks.
Truro, Royal Institution of Cornwall.
Tübingen (Germany), University Library.
Tunbridge, E. W., Esq., F.G.S., Rocklands, Woodbourne Road, Edgbaston, Birmingham.

Upsala (Sweden), University Library.

Vienna, Royal Natural History Court Museum, Geological Department.

Walker, Sir B. E., C.V.O., LL.D., Canadian Bank of Commerce, Toronto, Canada.
Wandsworth Public Library, West Hill, Wandsworth. S.W.
Warren, S. Hazzledine, Esq., F.G.S., Sherwood, Loughton, Essex.
Warrington Museum and Library.
Warwickshire Natural History and Archæological Society, The Museum, Warwick.
Washington, U.S. Geological Survey.
Watts, Professor W. W., M.A., F.R.S., Imperial College of Science, South Kensington. S.W.
Weg, Max, 3, Königstrasse, Leipzig, Germany.
Wesley and Son, William, 28, Essex Street, Strand. W.C.
West Ham Public Library. E.
West Hartlepool Public Library.
Whitby Literary and Philosophical Society, Museum, Whitby.
Wilmore, Albert, Esq., D.Sc., F.G.S., Fernbank, Colne, Lancashire.
Wiltshire Archæological and Natural History Society, Devizes.
Winchester College Natural History Society, Winchester.
Winwood, Rev. Henry H., M.A., F.G.S., *Local Secretary,* 11, Cavendish Crescent, Bath.
Wolverhampton Free Public Library.

Wood, J. G., Esq., M.A., F.S.A., F.G.S., 7, New Square, Lincoln's Inn. W.C.
Woodhead, J. H., Esq., F.G.S., 14, Staverton Road, Brondesbury Park, Willesden Green. N.W.
Woods, Henry, Esq., M.A., F.G.S., *Local Secretary*, Sedgwick Museum, Cambridge.
Woodward, A. Smith, Esq., LL.D., F.R.S., *Secretary*, British Museum (Nat. Hist.), South Kensington. S.W.
Woodward, Henry, Esq., LL.D., F.R.S., *President*, 13, Arundel Gardens, Notting Hill. W.
Worcester Public Library and Hastings Museum, Worcester.
Workington Public Library, Workington, Cumberland.
Wright, Joseph, Esq., F.G.S., 10, May Street, Belfast.
Würzburg (Germany), University Library.

Yorkshire Philosophical Society, Museum, York.
Young, George W., Esq., F.G.S., 34, Glenthorne Road, Hammersmith. W.
Yule, Miss A. F., Tarradale House, by Muir-of-Ord, Ross-shire. N.B.

CATALOGUE OF THE CONTENTS OF THE ANNUAL VOLUMES

ALREADY PUBLISHED BY

THE PALÆONTOGRAPHICAL SOCIETY.

Vol. I.	Issued March, 1848, for the Year 1847	The Crag Mollusca, Part I, Univalves, by Mr. S. V. Wood (pp. i—xii, 1—208, pls. i—xxi, and title-page).
,, II.	Issued July, 1849, for the year 1848	The Reptilia of the London Clay, Vol. I, Part I, Chelonia, &c., by Profs. Owen and Bell (pp. 1—76, pls. i—xxviii, viii A, x A, xiii A, xvi A, xviii A, xix*, xix B, xix C, xix D). The Eocene Mollusca, Part I, Cephalopoda, by Mr. F. E. Edwards (pp. 1—56, pls. i—ix).
,, III.[1]	Issued Aug., 1850, for the Year 1849	The Entomostraca of the Cretaceous Formations, by Mr. T. R. Jones (pp. 1—40, pls. i—vii). The Permian Fossils, by Prof. Wm. King (pp. i—xxxviii, 1—258, pls. i—xxviii*). The Reptilia of the London Clay, Vol. I, Part II, Crocodilia and Ophidia, &c., by Prof. Owen (pp. 1—68, pls. xxix, i—xvi, ii A). The Fossil Corals, Part I, Crag, London Clay, Cretaceous, by Messrs. Milne Edwards and Jules Haime (pp. i—lxxxv, 1—72, pls. i—xi).
,, IV.	Issued June, 1851, for the Year 1850	The Crag Mollusca, Part II, No. 1, by Mr. S. V. Wood (pp. 1—150, pls. i—xii). The Mollusca of the Great Oolite, Part I, Univalves, by Messrs. Morris and Lycett (pp. i—viii, 1—130, pls. i—xv). The Fossil Brachiopoda, Vol. I, Part III, No. 1, Oolitic and Liassic, by Mr. Davidson (pp. 1—64, pls. i—xiii).
,, V.	Issued June, 1851, for the Year 1851	The Reptilia of the Cretaceous Formations, by Prof. Owen (pp. 1—118, pls. i—xxxvii, vii A, ix A). The Fossil Corals, Part II, Oolitic, by Messrs. Milne Edwards and Jules Haime (pp. 73—146, pls. xii—xxx). The Fossil Lepadidæ, by Mr. Charles Darwin (pp. i—vi, 1—88, pls. i—v).
,, VI.	Issued Aug., 1852, for the Year 1852	The Fossil Corals, Part III, Permian and Mountain-limestone, by Messrs. Milne Edwards and Jules Haime (pp. 147—210, pls. xxxi—xlvi). The Fossil Brachiopoda, Vol. I, Part I, Tertiary, by Mr. Davidson (pp. 1—23, pls. i, ii). The Fossil Brachiopoda, Vol. I, Part II, No. 1, Cretaceous, by Mr. Davidson (pp. 1—54, pls. i—v). The Fossil Brachiopoda, Vol. I, Part III, No. 2, Oolitic, by Mr. Davidson (pp. 65—100, pls. xiv—xviii). The Eocene Mollusca, Part II, Pulmonata, by Mr. F. E. Edwards (pp. 57—122, pls. x—xv). The Echinoderms of the Crag, London Clay, &c., by Prof. E. Forbes (pp. i—viii, 1—36, pls. i—iv, and title-page).
,, VII.	Issued Dec., 1853, for the Year 1853	The Fossil Corals, Part IV, Devonian, by Messrs. Milne Edwards and Jules Haime (pp. 211—244, pls. xlvii—lvi). The Fossil Brachiopoda, Introduction to Vol. I, by Mr. Davidson (pp. 1—136, pls. i—ix). The Mollusca of the Chalk, Part I, Cephalopoda, by Mr. D. Sharpe (pp. 1—26, pls. i—x). The Mollusca of the Great Oolite, Part II, Bivalves, by Messrs. Morris and Lycett (pp. 1—80, pls. i—viii). The Mollusca of the Crag, Part II, No. 2, Bivalves, by Mr. S. V. Wood (pp. 151—216, pls. xiii—xx). The Reptilia of the Wealden Formations, Part I, Chelonia, by Prof. Owen (pp. 1—12, pls. i—ix).

[1] The Volume for the year 1849 consists of two separate portions, each of which is stitched in a paper cover, on which are printed the dates 1848, 1849, and 1850. The one portion contains 'Cretaceous Entomostraca' and 'Permian Fossils'; the other, 'London Clay Reptilia,' Part II, and 'Fossil Corals,' Part I.

CATALOGUE OF VOLUMES—Continued.

Vol. VIII.[1]	Issued May, 1855, for the Year 1854	The Fossil Brachiopoda, Vol. I, Part II, No. 2, Cretaceous (pp. 55—117, pls. vi—xii), with Appendix and Index to Vol. I, by Mr. Davidson (pp. 1—30, pl. A). The Reptilia of the Wealden Formations, Part II, Dinosauria, by Prof. Owen (pp. 1—54, pls. i—xix, xvi A). The Mollusca of the Great Oolite, Part III, Bivalves, by Messrs. Morris and Lycett (pp. 81—147, pls. ix—xv). The Fossil Corals, Part V, Silurian, by Messrs. Milne Edwards and Jules Haime (pp. 245—322, pls. lvii—lxxii). The Fossil Balanidæ and Verrucidæ, by Mr. Charles Darwin (pp. 1—44, pls. i, ii). The Mollusca of the Chalk, Part II, Cephalopoda, by Mr. D. Sharpe (pp. 27—36, pls. xi—xvi). The Eocene Mollusca, Part III, No. 1, Prosobranchiata, by Mr. F. E. Edwards (pp. 123—180, pls. xvi—xxiii).
„ IX.[2]	Issued Feb., 1857, for the Year 1855	The Mollusca of the Crag, Part II, No. 3, Bivalves, by Mr. S. V. Wood (pp. 217—342, pls. xxi—xxxi). The Reptilia of the Wealden Formations, Part III, by Prof. Owen (pp. 1—26, pls. i—xii). The Eocene Mollusca, Part III, No. 2, Prosobranchiata, continued, by Mr. F. E. Edwards (pp. 181—240, pls. xxiv—xxvii). The Mollusca of the Chalk, Part III, Cephalopoda, by Mr. D. Sharpe (pp. 37—68, pls. xvii—xxvii). The Tertiary Entomostraca, by Mr. T. R. Jones (pp. i—xii, 1—68, pls. i—vi). The Fossil Echinodermata, Oolitic, Vol. I, Part I, by Dr. Wright (pp. v—x, 1—154, pls. i—x).
„ X.	Issued April, 1858, for the Year 1856	The Fossil Echinodermata, Oolitic, Vol. I, Part II, by Dr. Wright (pp. 155—302, pls. xi—xxii). The Fossil Crustacea, Part I, London Clay, by Prof. Bell (pp. i—viii, 1—44, pls. i—xi). The Fossil Brachiopoda, Vol. II, Part IV, Permian, by Mr. Davidson (pp. 1—51, pls. i—iv). The Fossil Brachiopoda, Vol. II, Part V, No. 1, Carboniferous, by Mr. Davidson (pp. 1—48, pls. i—viii). The Reptilia of the Wealden Formations, by Prof. Owen, Part IV (pp. 8—26, pls. iv—xi), and Supplement No. 1 (pp. 1—7, pls. i—iii). The Reptilia of the London Clay, Vol. I (Supplement), by Prof. Owen (pp. 77—79, pls. xxviii A, xxviii B).
„ XI.	Issued Nov., 1859, for the Year 1857	The Fossil Echinodermata, Oolitic, Vol. I, Part III, by Dr. Wright (pp. 303—390, pls. xxiii—xxxvi). The Fossil Brachiopoda, Vol. II, Part V, No. 2, Carboniferous, by Mr. Davidson (pp. 49—80, pls. ix—xvi). The Reptilia of the Cretaceous Formations (Supplement No. 1), by Prof. Owen (pp. 1—19, pls. i—iv). The Reptilia of the Wealden Formations (Supplement No. 2), by Prof. Owen (pp. 20—44, pls. v—xii.) The Polyzoa of the Crag, by Prof. Busk (pp. i—xiv, 1—136, pls. i—xxii).
„ [XII.	Issued March, 1861, for the Year 1858	The Fossil Echinodermata, Oolitic, Vol. I, Part IV, by Dr. Wright (pp. 391—468, pls. xxxvii—xliii). The Eocene Mollusca, Part III, No. 3, Prosobranchiata continued, by Mr. F. E. Edwards (pp. 241—330, pls. xxviii—xxxiii). The Reptilia of the Cretaceous Formations (Supplements No. 2, No. 3), by Prof. Owen (pp. 27—30, pl. vii, pp. 1—25, pls. i—vi). The Reptilia of the Purbeck Limestones, by Prof. Owen (pp. 31—39, pl. viii). The Fossil Brachiopoda, Vol. II, Part V, No. 3, Carboniferous by Mr. Davidson (pp. 81—120, pls. xvii—xxvi).
„ XIII.	Issued Dec., 1861, for the Year 1859	The Fossil Brachiopoda, Part V, No. 4, Carboniferous, by Mr. Davidson (pp. 121—210, pls. xxvii—xlvii). The Reptilia of the Oolitic Formations, No. 1, Lower Lias, by Prof. Owen (pp. 1—14, pls. i—vi). The Reptilia of the Kimmeridge Clay, No. 1, by Prof. Owen (pp. 15, 16, pl. vii). The Eocene Mollusca, Part IV, No. 1, Bivalves, by Mr. S. V. Wood (pp. 1—74, pls. i—xiii).

[1] This Volume is marked on the outside 1855.
[2] This Volume is marked on the outside 1856.

CATALOGUE OF VOLUMES—Continued.

Vol. XIV. Issued May, 1863, for the Year 1860	The Fossil Brachiopoda, Vol. II, Part V, No. 5, Carboniferous, by Mr. Davidson (pp. 211—280, pls. xlviii—lv). The Reptilia of the Oolitic Formations, No. 2, Lower Lias, by Prof. Owen (pp. 1—26, pls. i—xi). The Reptilia of the Kimmeridge Clay, No. 2, by Prof. Owen (pp. 27, 28, pl. xii). The Fossil Estheriæ, by Prof. Rupert Jones (pp. i—x, 1—134, pls. i—v). The Fossil Crustacea, Part II, Gault and Greensand, by Prof. Bell (pp. i—vii, 1—40, pls. i—xi).
„ XV. Issued May, 1863, for the Year 1861	The Fossil Echinodermata, Oolitic, Vol. II, Part I (Asteroidea), by Dr. Wright (pp. 1—130, pls. i—x, x A, xi, xii). Supplement to the Great Oolite Mollusca, by Dr. Lycett (pp. 1—129, pls. xxxi—xlv).
„ XVI. Issued Aug., 1864, for the Year 1862	The Fossil Echinodermata, Cretaceous, Vol. I, Part I, by Dr. Wright (pp. 1—64, pls. i—iii, iii A, iv—vii, vii A, viii, xi). The Trilobites of the Silurian, Devonian, &c., Formations, Part I (Devonian and Silurian), by Mr. J. W. Salter (pp. 1—80, pls. i—vi). The Fossil Brachiopoda, Vol. III, Part VI, No. 1, Devonian, by Mr. Davidson (pp. 1—56, pls. i—ix). The Eocene Mollusca, Part IV, No. 2, Bivalves, by Mr. S. V. Wood (pp. 75—136, pls. xiv—xx). The Reptilia of the Cretaceous Formations (Supplement, No. 4), by Prof. Owen (pp. 1—18, pls. i—ix). The Reptilia of the Wealden and Purbeck Formations (Supplement, No. 3), by Prof. Owen (pp. 19—21, pl. x).
„ XVII. Issued June, 1865, for the Year 1863	The Trilobites of the Silurian, Devonian, &c., Formations, Part II, by Mr. J. W. Salter (pp. 81—128, pls. vii—xiv). The Fossil Brachiopoda, Vol. III, Part VI, No. 2, Devonian, by Mr. Davidson (pp. 57—131, pls. x—xx). The Belemnitidæ, Part I, Introduction, by Prof. Phillips (pp. 1—28). The Reptilia of the Liassic Formations, Part I, by Prof. Owen (pp. 1—40, pls. i—xvi).
„ XVIII. Issued April, 1866, for the Year 1864	The Fossil Echinodermata, Oolitic, Vol. II, Part II (Liassic Ophiuroidea), by Dr. Wright (pp. 131—154, pls. xiii—xviii). The Trilobites of the Silurian, Devonian, &c., Formations, Part III, by Mr. J. W. Salter (pp. 129—176, pls. xv—xxv). The Belemnitidæ, Part II, Liassic Belemnites, by Prof. Phillips (pp. 29—52, pls. i—vii). The Pleistocene Mammalia, Part I, Introduction, Felis spelæa, by Messrs. W. Boyd Dawkins and W. A. Sanford (pp. i—l, 1—28, pls. i—v). Title-pages, &c., to the Monographs on the Reptilia of the London Clay, Cretaceous, and Wealden Formations.
„ XIX.[1] Issued Dec., 1866, for the Year 1865	The Crag Foraminifera, Part 1, by Messrs. T. Rupert Jones, W. K. Parker, and H. B. Brady (pp. i—vi, 1—72, pls. i—iv). Supplement to the Fossil Corals, Part I, Tertiary, by Dr. Duncan (pp. i—iii, 1—66, pls. i—x). The Fossil Merostomata, Part I, Pterygotus, by Mr. H. Woodward (pp. 1—44, pls. i—ix). The Fossil Brachiopoda, Vol. III, Part VII, No. 1, Silurian, by Mr. Davidson (pp. 1—88, pls. i—xii).
„ XX. Issued June, 1867, for the Year 1866	Supplement to the Fossil Corals, Part IV, No. 1, Liassic, by Dr. Duncan (pp. i—iii, 1—44, pls. i—xi). The Trilobites of the Silurian, Devonian, &c., Formations, Part IV (Silurian), by Mr. J. W. Salter (pp. 177—214, pls. xxv*—xxx). The Fossil Brachiopoda, Vol. III, Part VII, No. 2, Silurian, by Mr. Davidson (pp. 89—168, pls. xiii—xxii). The Belemnitidæ, Part III, Liassic Belemnites, by Prof. Phillips (pp. 53—88, pls. viii—xx).
„ XXI. Issued June, 1868, for the Year 1867	Flora of the Carboniferous Strata, Part I, by Mr. E. W. Binney (pp. 1—32, pls. i—vi). Supplement to the Fossil Corals, Part IV, No. 2, Liassic, by Dr. Duncan (pp. 45—73, pls. xii—xvii). The Fossil Echinodermata, Cretaceous, Vol. I, Part II, by Dr. Wright (pp. 65—112, pls. ix, x, xii—xxi, xxi A, xxi B). The Fishes of the Old Red Sandstone, Part I, by Messrs. J. Powrie and E. Ray Lankester (pp. 1—32, pls. i—v). The Pleistocene Mammalia, Part II, Felis spelæa, continued, by Messrs. W. Boyd Dawkins and W. A. Sanford (pp. 29—124, pls. vi—xix).

[1] From 1865 onwards the Volumes are issued in two forms of binding: first, with all the Monographs stitched together and enclosed in one cover; secondly, with each of the Monographs separate, and the whole of the separate parts placed in an envelope. The previous Volumes are not in separate parts.

CATALOGUE OF VOLUMES—Continued.

Vol. XXII. Issued Feb., 1869, for the Year 1868	Supplement to the Fossil Corals, Part II, No. 1, Cretaceous, by Dr. Duncan (pp. 1—26, pls. i—ix). The Fossil Merostomata, Part II, Pterygotus, by Mr. H. Woodward (pp. 45—70, pls. x—xv). The Fossil Brachiopoda, Vol. III, Part VII, No. 3, Silurian, by Mr. Davidson (pp. 169—248, pls. xxiii—xxxvii). The Belemnitidæ, Part IV, Liassic and Oolitic Belemnites, by Prof. Phillips (pp. 89—108, pls. xxi—xxvii). The Reptilia of the Kimmeridge Clay, No. 3, by Prof. Owen (pp. 1—12, pls. i—iv). The Pleistocene Mammalia, Part III, Felis spelæa, concluded, with F. lynx, by Messrs. W. Boyd Dawkins and W. A. Sanford (pp. 125—176, pls. xx—xxii, xxii A, xxii B, xxiii).
„ XXIII. Issued Jan., 1870, for the Year 1869	Supplement to the Fossil Corals, Part II, No. 2, Cretaceous, by Dr. Duncan (pp. 27—46, pls. x—xv). The Fossil Echinodermata, Cretaceous, Vol. I, Part III, by Dr. Wright (pp. 113—136, pls. xxii—xxix, xxix A, xxix B). The Belemnitidæ, Part V, Oxford Clay, &c., Belemnites, by Prof. Phillips (pp. 109—128, pls. xxviii—xxxvi). The Fishes of the Old Red Sandstone, Part I (concluded), by Messrs. J. Powrie and E. Ray Lankester (pp. 33—62, pls. vi—xiv). The Reptilia of the Liassic Formations, Part II, by Prof. Owen (pp. 41—82, pls. xvii—xx). The Crag Cetacea, No. 1, by Prof. Owen (pp. 1—40, pls. i—v).
„ XXIV. Issued Jan., 1871, for the Year 1870	The Flora of the Carboniferous Strata, Part II, by Mr. E. W. Binney (pp. 33—62, pls. vii—xii). The Fossil Echinodermata, Cretaceous, Vol. I, Part IV, by Dr. Wright (pp. 137—160, pls. xxx—xxxix). The Fossil Brachiopoda, Vol. III, Part VII, No. 4, Silurian, by Mr. Davidson (pp. 249—397, pls. xxxviii—l). The Eocene Mollusca, Part IV, No. 3, Bivalves, by Mr. S. V. Wood (pp. 137—182, pls. xxi—xxv). The Fossil Mammalia of the Mesozoic Formations, by Prof. Owen (pp. i—vi, 1—115, pls. i—iv).
„ XXV. Issued June, 1872, for the Year 1871	The Flora of the Carboniferous Strata, Part III, by Mr. E. W. Binney (pp. 63—96, pls. xiii—xviii). The Fossil Merostomata, Part III, Pterygotus and Slimonia, by Mr. H. Woodward (pp. 71—120, pls. xvi—xx). Supplement to the Crag Mollusca, Part I (Univalves), by Mr. S. V. Wood, with an Introduction on the Crag District, by Messrs. S. V. Wood, jun., and F. W. Harmer (pp. i—xxxi, 1—98, pls. i—vii, and map). Supplement to the Reptilia of the Wealden (Iguanodon), No. IV, by Prof. Owen (pp. 1—15, pls. i—iii). The Pleistocene Mammalia, Part IV, Felis pardus, &c., by Messrs. W. Boyd Dawkins and W. A. Sanford (pp. 177—194, pls. xxiv, xxv). The Pleistocene Mammalia, Part V, Ovibos moschatus, by Mr. W. Boyd Dawkins (pp. 1—30, pls. i—v).
„ XXVI. Issued Oct., 1872, for the Year 1872	Supplement to the Fossil Corals, Part III (Oolitic), by Prof. Duncan (pp. 1—24, pls. i—vii), with an Index to the Tertiary and Secondary Species. The Fossil Echinodermata, Cretaceous, Vol. I, Part V, by Dr. Wright (pp. 161—184, pls. xl—xliv). The Fossil Merostomata, Part IV (Stylonurus, Eurypterus, Hemiaspis), by Mr. H. Woodward (pp. 121—180, pls. xxi—xxx). The Fossil Trigoniæ, No. I, by Dr. Lycett (pp. 1—52, pls. i—ix).

CATALOGUE OF VOLUMES—Continued.

Vol. XXVII. Issued Feb., 1874, for the Year 1873

- The Fossil Echinodermata, Cretaceous, Vol. I, Part VI, by Dr. Wright (pp. 185—224, pls. xlv—lii).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part I (Tertiary and Cretaceous), by Mr. Davidson (pp. 1—72, pls. i—viii).
- Supplement to the Crag Mollusca, Part II (Bivalves), by Mr. S. V. Wood (pp. 99—231, pls. viii—xi, and add. plate).
- Supplement to the Reptilia of the Wealden (Iguanodon), No. V, by Prof. Owen (pp. 1—18, pls. i, ii).
- Supplement to the Reptilia of the Wealden (Hylæochampsa), No. VI, by Prof. Owen (pp. 1—7).
- The Fossil Reptilia of the Mesozoic Formations, Part I, by Prof. Owen (pp. 1—14, pls. i, ii).

,, XXVIII. Issued July, 1874, for the Year 1874

- The Post-Tertiary Entomostraca, by Mr. G. S. Brady, Rev. H. W. Crosskey, and Mr. D. Robertson (pp. i—v, 1—232, pls. i—xvi).
- The Carboniferous Entomostraca, Part I (Cypridinidæ), by Prof. T. Rupert Jones and Messrs. J. W. Kirkby and G. S. Brady (pp. 1—56, pls. i—v).
- The Fossil Trigoniæ, No. II, by Dr. Lycett (pp. 53—92, pls. x—xix).

,, XXIX. Issued Dec. 1875, for the Year 1875

- The Flora of the Carboniferous Strata, Part IV, by Mr. E. W. Binney (pp. 97—147, pls. xix—xxiv).
- The Fossil Echinodermata, Cretaceous, Vol. I, Part VII, by Dr. Wright (pp. 225—264, pls. liii—lxii).
- The Fossil Trigoniæ, No. III, by Dr. Lycett (pp. 93—148, pls. xx—xxvii).
- The Fossil Reptilia of the Mesozoic Formations, Part II, by Prof. Owen (pp. 15—94, pls. iii—xxii).

,, XXX. Issued Dec., 1876, for the Year 1876

- The Carboniferous and Permian Foraminifera (the genus Fusulina excepted), by Mr. H. B. Brady (pp. 1—166, pls. i—xii).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part II, No. 1 (Jurassic and Triassic), by Mr. Davidson (pp. 73—144, pls. ix—xvi).
- Supplement to the Reptilia of the Wealden (Poikilopleuron and Chondrosteosaurus), No. VII, by Prof. Owen (pp. 1—7, pls. i—vi).

,, XXXI. Issued Feb., 1877, for the Year 1877

- Supplement to the Eocene Mollusca (Bivalves), by Mr. S. V. Wood, 2 plates.
- The Fossil Trigoniæ, No. IV, by Dr. Lycett (pp. 149—204, pls. xxviii—xl).
- The Eocene Mollusca (Univalves), Part IV, by Mr. S. V. Wood (pp. 331—361, pl. xxxiv).
- The Carboniferous Ganoid Fishes, Part I (Palæoniscidæ), by Dr. Traquair (pp. 1—60, pls. i—vii).
- The Fossil Reptilia of the Mesozoic Formations, Part III, by Prof. Owen (pp. 95—97, pls. xxiii, xxiv).
- The Fossil Elephants, Part I (E. antiquus), by Prof. Leith Adams (pp. 1—68, pls. i—v).

,, XXXII. Issued Mar., 1878, for the Year 1878

- The Fossil Echinodermata, Cretaceous, Vol. I, Part VIII, by Dr. Wright (pp. 265—300, pls. lxii A, lxiii—lxix).
- Index and Title Page to the Fossil Echinodermata, Oolitic, Vol. I (Echinoidea), by Dr. Wright (pp. 469—481).
- The Fossil Merostomata, Part V (Neolimulus, &c.), by Dr. H. Woodward (pp. 181—263, pls. xxxi—xxxvi, and title-page).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part II, No. 2 (Jurassic and Triassic), by Mr. Davidson (pp. 145—242, pls. xvii—xxix).
- The Lias Ammonites, Part I, by Dr. Wright (pp. 1—48, pls. i—viii).
- The Sirenoid and Crossopterygian Ganoids, Part I, by Prof. Miall (pp. 1—32, pls. i, i A, ii—v).
- Supplement to the Reptilia of the Wealden (Goniopholis, Petrosuchus, and Suchosaurus), No. VIII, by Prof. Owen (pp. 1—15, pls. i—vi).
- The Pleistocene Mammalia, Part A (Preliminary Treatise), by Prof. Boyd Dawkins (pp. i—xxxviii).

CATALOGUE OF VOLUMES—Continued.

Vol. XXXIII. Issued May, 1879, for the Year 1879
- The Eocene Flora, Vol. I, Part I, by Mr. J. S. Gardner and Baron Ettingshausen (pp. 1—38, pls. i—v).
- Second Supplement to the Crag Mollusca (Univalves and Bivalves), by Mr. S. V. Wood (pp. i, ii, 1—58, pls. i—vi, and title-page).
- The Fossil Trigoniæ, No. V, by Dr. Lycett (pp. 205—245, pl. xli, and title-page).
- The Lias Ammonites, Part II, by Dr. Wright (pp. 49—164, pls. ix—xviii).
- Supplement to the Reptilia of the Wealden (Goniopholis, Brachydectes, Nannosuchus, Theriosuchus, and Nuthetes), No. IX, by Prof. Owen (pp. 1—19, pls. i—iv).
- The Fossil Elephants, Part II (E. primigenius), by Prof. Leith Adams (pp. 69—146, pls. vi—xv).

„ XXXIV. Issued May, 1880, for the year 1880
- The Eocene Flora, Vol. I, Part II, by Mr. J. S. Gardner and Baron Ettingshausen (pp. 39—58, pls. vi—xi).
- The Fossil Echinodermata, Oolitic, Vol. II, Part III (Asteroidea and Ophiuroidea), by Dr. Wright (pp. 155—203, pls. xix—xxi, pp. i—iv, and title-page).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part III (Permian and Carboniferous), by Mr. Davidson (pp. 243—316, pls. xxx—xxxvii).
- The Lias Ammonites, Part III, by Dr. Wright (pp. 165—264, pls. xix—xl).
- The Reptilia of the London Clay, Vol. II, Part I (Chelone), by Prof. Owen (pp. 1—4 pls. i, ii).

„ XXXV. Issued May, 1881, for the Year 1881
- The Fossil Echinodermata, Cretaceous, Vol. I, Part IX, by Dr. Wright (pp. 301—324, pls. lxx—lxxv).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part IV (Devonian and Silurian, from Budleigh-Salterton Pebble Bed), by Mr. Davidson (pp. 317—368, pls. xxxviii—xlii).
- The Fossil Trigoniæ (Supplement No. 1), by Dr. Lycett (pp. 1—4).
- The Lias Ammonites, Part IV, by Dr. Wright (pp. 265—328, pls. xxii A, xxii B, xli—xlviii).
- The Reptilia of the Liassic Formations, Part III, by Prof. Owen (pp. 83—134, pls. xxi—xxxiii, and title-page).
- The Fossil Elephants, Part III (E. primigenius and E. meridionalis), by Prof. Leith Adams (pp. 147—265, pls. xvi—xxviii, and title-page).

„ XXXVI. Issued June, 1882, for the Year 1882
- The Eocene Flora, Vol. I, Part III, by Mr. J. S. Gardner and Baron Ettingshausen (pp. 59—86, pls. xii, xiii, and title-page).
- Third Supplement to the Crag Mollusca, by the late Mr. S. V. Wood (pp. 1—24, pl. i).
- The Fossil Echinodermata, Cret., Vol. I, Part X, by Dr. Wright (pp. 325—371, pls. lxxvi—lxxx, and title-page).
- Supplement to the Fossil Brachiopoda, Vol. IV, Part V, by Dr. Davidson (pp. 369—383, and title-page).
- Do., Vol. V, Part I (Devonian and Silurian), by Dr. Davidson (pp. 1—134, pls. i—vii).
- The Lias Ammonites, Part V, by Dr. Wright (pp. 329—400, pls. xlix—lii, lii A, liii—lxix).

„ XXXVII. Issued Oct., 1883, for the Year 1883
- The Eocene Flora, Vol. II, Part I, by Mr. J. S. Gardner (pp. 1—60, pls. i—ix)
- The Trilobites of the Silurian, Devonian, &c., Formations, Part V, by the late Mr. J. W. Salter (pp. 215—224, and title-page).
- The Carboniferous Trilobites, Part I, by Dr. H. Woodward (pp. 1—38, pls. i—vi).
- Supplement to the Fossil Brachiopoda, Vol. V, Part II (Silurian), by Dr. Davidson (pp. 135—242, pls. viii—xvii).
- The Fossil Trigoniæ (Supplement No. 2), by the late Dr. Lycett (pp. 5—19, pls. i—iv, and title-page).
- The Lias Ammonites, Part VI, by Dr. Wright (pp. 401—440, pls. lxx—lxxvii).

„ XXXVIII. Issued Dec., 1884, for the Year 1884
- The Eocene Flora, Vol. II, Part II, by Mr. J. S. Gardner (pp. 61—90, pls. x—xx).
- The Carboniferous Entomostraca, Part I, No. 2, by Prof. T. Rupert Jones, Mr. J. W. Kirkby, and Prof. G. S. Brady (pp. i—iii, 57—92, pls. vi, vii, and title-page).
- The Carboniferous Trilobites, Part II, by Dr. H. Woodward (pp. 39—86, pls. vii—x, and title-page).
- Supplement to the Fossil Brachiopoda, Vol. V, Part III, by Dr. Davidson (pp. 243—476, pls. xviii—xxi, and title-page).
- The Lias Ammonites, Part VII, by Dr. Wright (pp. 441—480, pls. lxxviii—lxxxvii).

CATALOGUE OF VOLUMES—Continued.

Vol. XXXIX. Issued Jan., 1886, for the Year 1885	The Eocene Flora, Vol. II, Part III, by Mr. J. S. Gardner (pp. 91—159, pls. xxi—xxvii, and title-page). The Stromatoporoids, Part I, by Prof. Alleyne Nicholson (pp. i—iii, 1—130, pls. i—xi). The Fossil Brachiopoda (Bibliography), Vol. VI (pp. 1—163), by the late Dr. Davidson and Mr. W. H. Dalton. The Lias Ammonites, Part VIII, by the late Dr. Wright (pp. 481—503, pl. lxxxviii, and title-page).
„ XL. Issued Mar., 1887, for the Year 1886	The Morphology and Histology of Stigmaria Ficoides, by Prof. W. C. Williamson (pp. i—iv, 1—62, pls. i—xv). The Fossil Sponges, Part I, by Dr. G. J. Hinde (pp. 1—92, pls. i—viii). The Jurassic Gasteropoda, Part I, No. 1, by Mr. W. H. Hudleston (pp. 1—56). The Inferior Oolite Ammonites, Part I, by Mr. S. S. Buckman (pp. 1—24, pls. i—vi). The Pleistocene Mammalia, Part VI, by Prof. Boyd Dawkins (pp. 1—29, pls. i—vii).
„ XLI. Issued Jan., 1888, for the Year 1887	The Fossil Sponges, Part II, by Dr. G. J. Hinde (pp. 93—188, pl. ix). The Palæozoic Phyllopoda, Part I, by Prof. T. R. Jones and Dr. Woodward (pp. 1—72, pls. i—xii). The Jurassic Gasteropoda, Part I, No. 2, by Mr. W. H. Hudleston (pp. 57—136, pls. i—vi). The Inferior Oolite Ammonites, Part II, by Mr. S. S. Buckman (pp. 25—56, pls. vii—xiv).
„ XLII. Issued Mar., 1889, for the Year 1888	The Stromatoporoids, Part II, by Prof. Alleyne Nicholson (pp. 131—158, pls. xii—xix). The Tertiary Entomostraca (Supplement), by Prof. T. Rupert Jones and Mr. C. D. Sherborn (pp. 1—55, pls. i—iii). The Jurassic Gasteropoda, Part I, No. 3, by Mr. W. H. Hudleston (pp. 137—192, pls. vii—xi). The Inferior Oolite Ammonites, Part III, by Mr. S. S. Buckman (pp. 57—144, pls. xv, xxiii A). The Devonian Fauna of the South of England, Part I, by the Rev. G. F. Whidborne (pp. i, ii, 1—46, pls. i—iv). Title-pages and Prefaces to the Monographs on the Reptilia of the Wealden and Purbeck (Supplements), Kimmeridge Clay, and Mesozoic Formations, and on the Cetacea of the Red Crag.
„ XLIII. Issued Mar., 1890, for the Year 1889	The Cretaceous Entomostraca (Supplement), by Prof. T. Rupert Jones and Dr. G. J. Hinde (pp. i—viii, 1—70, pls. i—iv). The Jurassic Gasteropoda, Part I, No. 4, by Mr. W. H. Hudleston (pp. 193—224, pls. xii—xvi). The Inferior Oolite Ammonites, Part IV, by Mr. S. S. Buckman (pp. 145—224, pls. xxiv—xxxvi). The Devonian Fauna of the South of England, Part II, by the Rev. G. F. Whidborne (pp. 47—154, pls. v—viii, viii A, ix—xv).
„ XLIV. Issued Apr., 1891, for the Year 1890	The Stromatoporoids, Part III, by Prof. Alleyne Nicholson (pp. 159—202, pls. xx—xxv). The Fossil Echinodermata, Cretaceous, Vol. II, Part I (Asteroidea), by Mr. W. Percy Sladen (pp. 1—28, pls. i—viii). The Inferior Oolite Ammonites, Part V, by Mr. S. S. Buckman (pp. 225—256, pls. xxxvii—xliv). The Devonian Fauna of the South of England, Part III, by the Rev. G. F. Whidborne (pp. 155—250, pls xvi—xxiv). Title-pages to the Supplement to the Fossil Corals, by Prof. Duncan.
„ XLV. Issued Feb., 1892, for the Year 1891	The Jurassic Gasteropoda, Part I, No. 5, by Mr. W. H. Hudleston (pp. 225—272, pls. xvii—xx). The Inferior Oolite Ammonites, Part VI, by Mr. S. S. Buckman (pp. 257—312, pls. xlv—lvi). The Devonian Fauna of the South of England, Part IV (*Conclusion of* Vol. I) (pp. 251—344, pls. xxv—xxxi, and title-page). „ „ Vol. II, Part I, by the Rev. G. F. Whidborne (pp. 1—56, pls. i—v).

CATALOGUE OF VOLUMES—Continued.

Vol. XLVI. Issued Nov., 1892, for the Year 1892

- The Stromatoporoids, Part IV (*Conclusion*), by Prof. Alleyne Nicholson (pp. 203—234, pls. xxvi—xxix, and title-page).
- The Palæozoic Phyllopoda, Part II, by Prof. T. R. Jones and Dr. Woodward (pp. 73—124, pls. xiii—xvii).
- The Jurassic Gasteropoda, Part I, No. 6, by Mr. W. H. Hudleston (pp. 273—324, pls. xxi—xxvi).
- The Inferior Oolite Ammonites, Part VII, by Mr. S. S. Buckman (pp. 313—344, pls. lvii—lxxvi).
- The Devonian Fauna of the South of England, Vol. II, Part II, by the Rev. G. F. Whidborne (pp. 57—88, pls. vi—x).

,, XLVII. Issued Dec., 1893, for the Year 1893

- The Fossil Sponges, Part III, by Dr. G. J. Hinde (pp. 189—254, pls. x—xix).
- The Fossil Echinodermata, Cretaceous, Vol. II, Part II (Asteroidea), by Mr. W. Percy Sladen (pp. 29—66, pls. ix—xvi).
- The Inferior Oolite Ammonites, Part VIII, by Mr. S. S. Buckman (pp. 345—376, pls. lxxvii—xcii).
- The Devonian Fauna of the South of England, Vol. II, Part III, by the Rev. G. F. Whidborne (pp. 89—160, pls. xi—xvii).

,, XLVIII. Issued Nov., 1894, for the Year 1894

- The Jurassic Gasteropoda, Part I, No. 7, by Mr. W. H. Hudleston (pp. 325—390, pls. xxvii—xxxii).
- Carbonicola, Anthracomya, and Naiadites, Part I, by Dr. W. Hind (pp. 1—80, pls. i—xi).
- The Inferior Oolite Ammonites, Part IX, by Mr. S. S. Buckman (pp. 377—456, pls. xciii—ciii).
- The Fishes of the Old Red Sandstone, Part II, No. 1, by Dr. R. H. Traquair (pp. 63—90, pls. xv—xviii).

,, XLIX. Issued Oct., 1895, for the Year 1895

- The Crag Foraminifera, Part II, by Prof. T. R. Jones (pp. 73—210, pls. v—vii).
- The Jurassic Gasteropoda, Part I, No. 8, by Mr. W. H. Hudleston (pp. 391—444, pls. xxxiii—xl).
- Carbonicola, Anthracomya, and Naiadites, Part II, by Dr. W. Hind (pp. 81—170, pls. xii—xx).
- The Devonian Fauna of the South of England, Vol. II, Part IV, by the Rev. G. F. Whidborne (pp. 161—212, pls. xviii—xxiv).

,, L. Issued Oct., 1896, for the Year 1896

- The Crag Foraminifera, Part III, by Prof. T. R. Jones (pp. 211—314).
- The Jurassic Gasteropoda, Part I, No. 9, by Mr. W. H. Hudleston (pp. 445—514, pls. xli—xliv, and title-page).
- Carbonicola, Anthracomya, and Naiadites, Part III, by Dr. W. Hind (pp. 171—182, pl. xxi, and title-page).
- The Carboniferous Lamellibranchiata, Part I, by Dr. W. Hind (pp. 1—80, pls. i, ii).
- The Devonian Fauna of the South of England, Vol. III, Part I, by the Rev. G. F. Whidborne (pp. 1—112, pls. i—xvi).

,, LI. Issued Dec., 1897, for the Year 1897

- The Crag Foraminifera, Part IV, by Prof. T. R. Jones (pp. vii—xv, 315—402, and title-page).
- The Carboniferous Lamellibranchiata, Part II, by Dr. W. Hind (pp. 81—208, pls. iii—xv).
- The Carboniferous Cephalopoda of Ireland, Part I, by Dr. A. H. Foord (pp. 1—22, pls. i—vii).
- The Devonian Fauna of the South of England, Vol. III, Part II, by the Rev. G. F. Whidborne (pp. 113—178, pls. xvii—xxi).

,, LII. Issued Dec., 1898, for the Year 1898

- The Palæozoic Phyllopoda, Part III, by Prof. T. R. Jones and Dr. Woodward (pp. 125—176, pls. xviii—xxv).
- The Carboniferous Lamellibranchiata, Part III, by Dr. W. Hind (pp. 209—276, pls. xvi—xxv).
- The Inferior Oolite Ammonites, Part X, by Mr. S. S. Buckman (pp. i—xxxii, Suppl. pls. i—iv).
- The Carboniferous Cephalopoda of Ireland, Part II, by Dr. A. H. Foord (pp. 23—48, pls. viii—xvii).
- The Devonian Fauna of the South of England, Vol. III, Part III, by the Rev. G. F. Whidborne (pp. 179—236, pls. xxii—xxxviii).

CATALOGUE OF VOLUMES—Continued.

Vol. LIII.	Issued Dec., 1899, for the Year 1899	The Palæozoic Phyllopoda, Part IV, by Prof. T. R. Jones and Dr. Woodward (pp. i—xv, 175, 176, 177—211, pls. xxvi—xxxi, and title-page). The Cretaceous Lamellibranchia, Part I, by Mr. H. Woods (pp. 1—72, pls. i—xiv). The Carboniferous Lamellibranchiata, Part IV, by Dr. W. Hind (pp. 277—360, pls. xxvi—xxxix). The Inferior Oolite Ammonites, Part XI, by Mr. S. S. Buckman (pp. xxxiii—lxiv, pls. v—xiv).
„ LIV.	Issued Dec., 1900, for the Year 1900	The Cretaceous Lamellibranchia, Part II, by Mr. H. Woods (pp. 73—112. pls. xv—xix). The Carboniferous Lamellibranchiata, Part V, by Dr. W. Hind (pp. 361—476, pls. xl—liv). The Carboniferous Cephalopoda of Ireland, Part III, by Dr. A H. Foord (pp. 49—126, pls. xviii—xxxii). The British Pleistocene Mammalia, Title-page for Vol. I, by Messrs. Dawkins and Sanford. The Structure of Carboniferous Plants, Title-page, by Mr. E. W. Binney.
„ LV.	Issued Dec., 1901, for the Year 1901	The Cretaceous Lamellibranchia, Part III, by Mr. H. Woods (pp. 113—144, pls. xx—xxvi). The Carboniferous Lamellibranchiata, Vol. II, Part I, by Dr. W. Hind (pp. 1—34, pls. i—vi), Title-page and Index for Vol. I. The Carboniferous Cephalopoda of Ireland, Part IV, by Dr. A. H. Foord (pp. 127—146, pls. xxxiii—xxxix). British Graptolites, Part I, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. 1—54, pls. i—iv). Ganoid Fishes of British Carboniferous Formations—Part I, Palæoniscidæ, No. 2, by Dr. Ramsay H. Traquair (pp. 61—87, pls. viii—xviii).
„ LVI.	Issued Dec., 1902, for the Year 1902	The Cave Hyæna, by Prof. S. H. Reynolds (pp. 1—25, pls. i—xiv). The Fishes of the English Chalk, Part I, by Dr. A. Smith Woodward (pp. 1—56, pls. i—xiii). The Cretaceous Lamellibranchia, Part IV, by Mr. H. Woods (pp. 145—196, pls. xxvii—xxxviii). British Graptolites, Part I, No. 2, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. i—xxviii, 55—94, pls. v—xiii).
„ LVII.	Issued Dec., 1903, for the Year 1903	The Fishes of the English Chalk, Part II, by Dr. A. Smith Woodward (pp. 57—96, pls. xiv—xx). The Cretaceous Lamellibranchia, Part V, by Mr. H. Woods (pp. i—xliii, 197—232, pls. xxxix—xlii), Title-page and Index for Vol. I. The Carboniferous Lamellibranchiata, Vol. II, Part II, by Dr. W. Hind (pp. 35—124, pls. vii—xxi). The Carboniferous Cephalopoda of Ireland, Part V, by Dr. A. H. Foord (pp. 147—234, pls. xl—xlix), Title-page and Index. The Lower Palæozoic Trilobites of Girvan, Part I, by Mr. F. R. Cowper Reed (pp. 1—48, pls. i—vi). British Graptolites, Part III, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. xxix—lii, 103—134, pls. xiv—xix).
„ LVIII.	Issued Dec., 1904, for the Year 1904	The Fishes of the Old Red Sandstone, Part II, No. 2, by Dr. R. H. Traquair (pp. 91—118, pls. xix—xxvi). The Cretaceous Lamellibranchia, Vol. II, Part I, by Mr. H. Woods (pp. 1—56, pls. i—vii). The Carboniferous Lamellibranchiata, Vol. II, Part III, by Dr. W. Hind (pp. 125—216, pls. xxii—xxv). The Inferior Oolite Ammonites, Part XII, by Mr. S. S. Buckman (pp. lxv—clxviii, pls. xv—xix). The Lower Palæozoic Trilobites of Girvan, Part II, by Mr. F. R. Cowper Reed (pp. 49—96, pls. vii—xiii). British Graptolites, Part IV, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. liii—lxxii, 135—180, pls. xx—xxv).

CATALOGUE OF VOLUMES—Continued.

Vol. LIX. Issued Nov., 1905, for the Year 1905	The Fossil Echinodermata, Cretaceous, Vol. II, Part III, by Mr. W. K. Spencer (pp. 67—90, pls. xvii—xxvi). The Cretaceous Lamellibranchia, Vol. II, Part II, by Mr. H. Woods (pp. 57—96, pls. viii—xi). The Carboniferous Lamellibranchiata, Vol. II, Title-pages and Index, by Dr. W. Hind. The Inferior Oolite Ammonites, Part XIII, by Mr. S. S. Buckman (pp. clxix—ccviii, pls. xx—xxiv). The Cornbrash Fauna, Part I, by the Rev. J. F. Blake (pp. 1—100, pls. i—ix).
„ LX. Issued Dec., 1906, for the Year 1906	The Pleistocene Bears, by Prof. S. H. Reynolds (pp. 1—35, pls. i—viii). The Fishes of the Old Red Sandstone, Part II, No. 3, by Dr. R. H. Traquair (pp. 119—130, pls. xxvii—xxxi). The Cretaceous Lamellibranchia, Vol. II, Part III, by Mr. H. Woods (pp. 97—132, pls. xii—xix). The Lower Palæozoic Trilobites of Girvan, Part III, by Mr. F. R. Cowper Reed (pp. 97—186, Title-page and Index, pls. xiv—xx). The Cambrian Trilobites, Part I, by Mr. P. Lake (pp. 1—28, pls. i, ii). British Graptolites, Part V, by Miss Elles and Miss Wood, edited by Prof. Lapworth (pp. lxxiii—xcvi, 181—216, pls. xxvi, xxvii).
„ LXI. Issued Dec., 1907, for the Year 1907	The Sirenoid Ganoids, Part II, by Prof. L. C. Miall (pp. 33—34, Title-page, Preface, and Postscript). Ganoid Fishes of British Carboniferous Formations, Part I, Palæoniscidæ, No. 3, by Dr. R. H. Traquair (pp. 87—106, pls. xix—xxiii). The Fishes of the English Chalk, Part III, by Dr. A. Smith Woodward (pp. 97—128, pls. xxi—xxvi). The Inferior Oolite Ammonites, Part XIV, by Mr. S. S. Buckman (pp. ccix—cclxii, Title-pages, Preface, and Index). The Cretaceous Lamellibranchia, Vol. II, Part IV, by Mr. H. Woods (pp. 133—180, pls. xx—xxvii). The Fossil Echinodermata, Cretaceous, Vol. II, Part IV, by Mr. W. K. Spencer (pp. 91—132, pls. xxvii—xxix). The British Conulariæ, by Miss Ida L. Slater (pp. 1—40, pls. i—v, Title-page and Index). The Cambrian Trilobites, Part II, by Mr. P. Lake (pp. 29—48, pls. iii, iv). British Graptolites, Part VI, by Miss Elles and Miss Wood (Mrs. Shakespear), edited by Prof. Lapworth (pp. xcvii—cxx, 217—272, pls. xxviii—xxxi). The Devonian Fauna of the South of England, Vol. II, Part V, and Vol. III, Part IV, by the Rev. G. F. Whidborne (Vol. II, pp. 215—222, Title-page and Index; Vol. III, pp. 237—247, Title-page and Index). The Cornbrash Fauna, Part II, by the Rev. J. F. Blake (pp. 101—102, Title-page and Index).
„ LXII. Issued Dec., 1908, for the Year 1908	The Fishes of the English Chalk, Part IV, by Dr. A. Smith Woodward (pp. 129— pls. xxvii—xxxii). Illustrations of Type Specimens of Inferior Oolite Ammonites (pls. i—vii). The Cretaceous Lamellibranchia, Vol. II, Part V, by Mr. H. Woods (pp. 181—216, pls. xxviii—xxxiv). The Fossil Echinodermata, Cretaceous, Vol. II, Part V, by Mr. W. K. Spencer (pp. 133—138, Title-page and Index). The Cambrian Trilobites, Part III, by Mr. P. Lake (pp. 49—64, pls. v, vi.) British Graptolites, Part VII, by Miss Elles and Miss Wood (Mrs. Shakespear), edited by Prof. Lapworth (pp. cxxi—cxlviii, 273—358, pl. xxxii—xxxv).
„ LXIII. Issued Dec., 1909, for the Year 1909	The Pleistocene Canidæ, by Prof. S. H. Reynolds (pp. 1—28, pls. i—vi). Ganoid Fishes of British Carboniferous Formations, Part I, Palæoniscidæ, No. 4, by Dr. R. H. Traquair (pp. 107—122, pls. xxiv—xxx). The Fishes of the English Chalk, Part V, by Dr. A. Smith Woodward (pp. 153—184, pls. xxxiii—xxxviii). The Cretaceous Lamellibranchia, Vol. II, Part VI, by Mr. H. Woods (pp. 217—260, pls. xxxv—xliv). The Mollusca of the Chalk, Part I, Cephalopoda, by Mr. D. Sharpe (Title-page and Index). The Belemnitidæ, by Prof. Phillips (Title-page and Index).

CATALOGUE OF VOLUMES—Continued.

Vol. LXIV.	Issued Jan., 1911, for the Year 1910	Ganoid Fishes of British Carboniferous Formations, Part I, Palæoniscidæ, No. 5, by Dr. R. H. Traquair (pp. 123—158, pls. xxxi—xxxv). The Fishes of the English Chalk, Part VI, by Dr. A. Smith Woodward (pp. 185—224, pls. xxxix—xlvi). The Cretaceous Lamellibranchia, Vol. II, Part VII, by Mr. H. Woods (pp. 261—284, pls. xlv—l). The Carboniferous Arachnida, by Mr. R. I. Pocock (pp. 1—84, pls. i—iii). British Graptolites, Part VIII, by Miss Elles and Miss Wood (Mrs. Shakespear), edited by Prof. Lapworth (pp. 359—414, pls. xxxvi—xli).
,, LXV.	Issued Feb., 1912, for the Year 1911	The Pleistocene Mustelidæ, by Prof. S. H. Reynolds (pp. 1—28, pls. i—viii). Ganoid Fishes of British Carboniferous Formations, Part I, Palæoniscidæ, No. 6, by Dr. R. H. Traquair (pp. 159—180, pls. xxxvi—xl). The Fishes of the English Chalk, Part VII, by Dr. A. Smith Woodward (pp. i—viii, 225—264, pls. xlvii—liv, including Title-page and Index). The Cretaceous Lamellibranchia, Vol. II, Part VIII, by Mr. H. Woods (pp. 285—340, pls. li—liv). The Fossil Sponges, Title-page and Index to Vol. I, by Dr. G. J. Hinde (pp. 255—264).

Palæontographical Society, 1911.

A MONOGRAPH

OF THE

BRITISH PLEISTOCENE MAMMALIA

VOL. II, PART IV.

THE MUSTELIDÆ.

BY

SIDNEY H. REYNOLDS, M.A., F.G.S.,

PROFESSOR OF GEOLOGY IN THE UNIVERSITY OF BRISTOL.

Pages 1—28; Plates I—VIII;
Title-page and Table of Contents of Vol. II.

LONDON:
PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY,
1912.

PRINTED BY ADLARD AND SON, LONDON AND DORKING.

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1911.

LONDON:

MDCCCCXII.

MONOGRAPH OF THE BRITISH PLEISTOCENE MAMMALIA.

VOL. II.

ORDER OF BINDING AND DATES OF PUBLICATION.

PARTS AND PAGES	PLATES	ISSUED IN VOL. FOR YEAR	PUBLISHED
General Title. Table of Contents of Vol. II	—	1911	February, 1912
Cave Hyæna, pp. 1—25	—XIV	1902	December, 1902
Bears, pp. 1—35	I—VIII	1906	December, 1906
Canidæ, pp. 1—28	I—VI	1909	December, 1909
Mustelidæ, pp. 1—28	I—VI	1911	February, 1912

A MONOGRAPH

OF THE

BRITISH PLEISTOCENE MAMMALIA

VOL. II.

BRITISH PLEISTOCENE HYÆNIDÆ, URSIDÆ, CANIDÆ, AND MUSTELIDÆ.

BY

SIDNEY H. REYNOLDS, M.A., F.G.S.,

PROFESSOR OF GEOLOGY IN THE UNIVERSITY OF BRISTOL.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1902—1912.

PRINTED BY ADLARD AND SON, LONDON AND DORKING.

TABLE OF CONTENTS.

PART I.

PART II.

PART III.

PART III—*continued.*

PART IV.

MONOGRAPH

ON

THE BRITISH MAMMALIA

OF THE

PLEISTOCENE PERIOD

THE MUSTELIDÆ.

Order—CARNIVORA.

Family—MUSTELIDÆ.

I. INTRODUCTION.

The Pleistocene Mustelidæ,[1] which form the subject of the present memoir, are an easier group to deal with than either the Ursidæ or Canidæ, not showing the variability and inconstancy of character which render it so difficult to come to a satisfactory conclusion about the mutual relationship of the members of the above groups. Including, as the group does, the glutton, badger, and otter, in addition to the Mustelinæ (marten, polecat, stoat, weasel, etc.), it is somewhat too extensive and diverse to be conveniently treated from the historical aspect as a single entity. In the following paragraphs only the literature of a more general character will be referred to, each species being subsequently considered separately.

As was the case with the bears and hyænas, the remains from the great Continental caves attracted attention at an earlier date than those of Britain, Goldfuss[2] recording bones of the glutton from the caves of Gailenreuth in 1818

[1] As in a previous memoir dealing with the Pleistocene Canidæ, the classification and nomenclature adopted are those of Flower and Lydekker, 'An Introduction to the Study of Mammalia, Living and Extinct' (1891). The generic name *Mustela* is employed in a wider sense than is now usual, most zoologists adopting Nilsson's name *Putorius* for the polecat, stoat and weasel.

[2] 'Nova Acta Acad. Caes. Leop.,' ix, 1818, p. 313, and 'Säugethiere der Vorwelt,' p. 468.

and Sundvig in 1823, and Schmerling[1] those of the badger, marten, and polecat, from the caves of Liège in 1833. Marcel de Serres, Dubrueil and Jeanjean[2] figured an otter's mandible from Lunel Viel in 1839, while Croizet and Jobert[3] recorded the same species from the Puy-de-Dôme deposits in 1828. The remains of the smaller Mustelidæ were naturally not as a rule recognised at so early a date as those of the larger species, but Buckland,[4] as early as 1822, figured musteline teeth from Kirkdale, which he attributed to the weasel, and Goldfuss[5] figured a mandible from Gailenreuth, which he attributed to a *Viverra*. Schmerling,[6] however, pointed out that the latter bone was musteline.

The records to the date of writing were summarised by H. v. Meyer[7] (1832), F. Holl[8] (1829—1831), de Blainville[9] (1844), and Giebel[10] (1847), while Owen, in 1842,[11] and subsequently in 1846,[12] gave a full account of the available information regarding British occurrences. Gervais[13] (1859) dealt fully with all French records.

Five species of Mustelidæ were recorded by Falconer[14] (1868) from the various caves of Gower, and other records were given by Dawkins[15] (1869) in his paper on the "Distribution of British Post-glacial Mammals."

Very little has been written concerning Musteline remains from Ireland, though Adams,[16] in 1881, recorded the marten and badger from Ballynamintra, co. Waterford, and Scharff the badger, otter and stoat from the caves of co. Clare,[17] and the stoat from Kesh,[18] co. Sligo.

The most important records of quite recent date in England are those of the Ightham[19] fissure, in which, in addition to *Mustela robusta*, the polecat, weasel and badger were met with.

During comparatively recent times a number of important papers dealing with the Pleistocene Mustelidæ have been published on the Continent. E. Cornalia, in his 'Mammifères fossiles de Lombardie'[20] (1858—1871), described remains of the badger, marten, and polecat, some of the polecat skulls being very large. This

1 'Recherches Oss. foss. Cavernes de Liège,' I, pp. 158—166; II, pp. 5—15.

2 'Recherches Oss. humatiles Cavernes de Lunel Viel,' p. 70, pl. ii, figs. 14 and 15.

3 'Recherches Oss. foss. Dept. Puy-de-Dôme,' p. 89.

4 'Phil. Trans.,' cxii, p. 182, pl. xx.

5 'Die Umgebungen von Muggendorf,' p. 282, pl. v, fig. 3.

6 'Recherches Oss. foss. Cavernes de Liège,' ii, p. 5.

7 'Palæologica,' p. 47.

8 'Handbuch der Petrefactenkunde,' p. 36.

9 'Ostéographie,' fasc. 4.

10 'Fauna der Vorwelt,' i, pp. 55—64.

11 "Brit. Foss. Mammals," 'Rep. Brit. Assoc.' (Manchester, 1842), pp. 70—72.

12 'Brit. Foss. Mamm. and Birds,' pp. 109—122.

13 'Zoologie et Paléontologie Françaises,' pp. 243—253.

14 'Pal. Mem.,' p. 525.

15 'Quart. Journ. Geol. Soc.,' xxv, p. 192.

16 'Trans. Roy. Dublin Soc.,' (2) i, p. 205.

17 'Trans. Roy. Irish Acad.,' xxxiii, B, pt. i, pp. 40—43.

18 Ibid., xxxii, B, pt. 4, p. 205.

19 'Quart. Journ. Geol. Soc.,' l, p. 200, and lv, p. 425.

20 'Pal. Lomb.,' ed. Stoppani, ser. 2.

paper was followed in 1879 by Liebe's[1] account of the caves at Vypustek, in Moravia, where glutton, marten, stoat, and polecat were met with. In Woldrich's[2] three beautifully illustrated papers (1880, 1882, 1884), on the fauna of Zuzlawitz, near Winterberg, in the Böhmerwald, remains of polecat, stoat and weasel are figured, and in particular some very large skulls, which are attributed to the polecat, closely resemble the form afterwards described by Newton as *Mustela robusta*. Lastly, in 1886 appeared an important paper by Winterfeld,[3] giving a general account of the Quaternary Musteline remains of Germany.

II. GENERAL ACCOUNT OF THE VARIOUS BRITISH MUSTELIDÆ.

Mustela martes, the Pine Marten.

Two British species of marten, the pine marten (*Mustela martes*, Linn., or *abietum*, Fleming) and the beech marten (*Mustela foina*, Erxl.), have commonly been recognised as members of the British fauna. Alston,[4] however, shows good reason for believing that *Mustela martes* is identical with *Mustela sylvatica* of Nilsson, and that *Mustela foina* is not really an inhabitant of the British Isles. He mentions among others the following points of difference between the skulls of *M. martes* and *M. foina*, though many of them appear to be inconstant or inappreciable.

M. martes.	*M. foina.*
1. The breadth of the skull across the zygomatic arches is rather more than half the length.	1. The breadth of the skull across the zygomatic arches is much more than half the length.
2. The arches are highest posteriorly, whence they slope rather suddenly downwards and forwards.	2. The arches are regularly curved, and broadest and highest in the middle.
3. The sides of the muzzle are nearly parallel.	3. The sides of the muzzle are converging.
4. The anterior narial opening is oval.	4. The anterior narial opening is heart-shaped.
5. The palate is comparatively narrow.	5. The palate is comparatively broad.
6. The upper premolars are placed regularly in the line of the series; the fourth has the inner cusp large and placed nearly at right angles to the axis of the tooth.	6. The upper premolars are crowded, and often placed diagonally, their anterior extremities being directed inwards; the inner cusp is small and placed somewhat diagonally.
7. $\overline{\text{m. 1}}$ has a slightly developed inner tubercle.	7. $\overline{\text{m. 1}}$ has a well-developed inner tubercle.

The marten was not mentioned by Owen in his 'British Fossil Mammals and

[1] 'Sitzb. k. Akad. Wiss. Wien,' lxxix, pt. i, p. 472.

[2] Ibid., lxxxii, pt. i, p. 32; lxxxiv, pt. 1, p. 194; and lxxxviii, pt. i, p. 993.

[3] 'Ueber quartäre Mustelidenreste Deutschlands,' Berlin.

[4] 'Proc. Zool. Soc.,' 1879, pp. 468—474, and 'Zoologist,' iii, 1879, pp. 441—448.

Birds,' and was not included by Dawkins in his list[1] of preglacial mammals, but part of a right mandibular ramus found in the Upper Freshwater Bed at West Runton was described by Newton.[2]

Records of the remains of the marten in British Pleistocene deposits are scanty. Dawkins and Sanford[3] mentioned a skull and lower jaw imbedded in breccia in the Williams collection from Bleadon. Falconer[4] detected marten remains which he attributed with hesitation to *Mustela foina* in three of the Gower caves, viz. Long Hole, Ravenscliff, and Spritsail Tor. Adams[5] recorded it from Ballynamintra, co. Waterford.

Scharff[6] mentioned that while abundant remains of martens were found in the Newhall and Barntick caves, co. Clare, these were all in the upper strata, and hence, it may be concluded, were probably not Pleistocene. A (probably) Prehistoric skull from Edenvale, co. Clare, and a mandibular ramus from the Langwith cave are figured on Pl. II, figs. 4, 5, of the present memoir. Cuvier[7] and Krüger[8] have alluded to the occurrence of bones of marten at Gailenreuth.

Mustela robusta, THE GIANT POLECAT.

This name was applied by Newton[9] to the remains of a large Musteline found in England, as yet only in the Ightham fissure. In the first instance only a left humerus, a right ulna and certain bones of the extremities were found, and as a result of a careful comparison with the corresponding bones of the marten and polecat, Newton arrived at the conclusion that they were distinct. A further series of limb-bones with part of a skull and mandible was described and figured by the same author[10] in 1899, and their affinities to the polecat rather than to the marten were pointed out.

Though the Ightham specimens were the first remains of the giant polecat which had been found in Britain, such had long been known on the Continent. Cornalia[11] (1870) had figured large fossil skulls of polecat from Lombardy. Woldrich[12] (1881—1883), others from Zuzlawitz, near Winterberg, in Bohemia,

[1] 'Quart. Journ. Geol. Soc.,' xxv (1869), p. 210.

[2] 'Mem. Geol. Surv.,' "Vert. of Forest Bed," p. 25.

[3] "British Pleistocene Mammalia: Felidæ," 'Pal. Soc.' (1866), p. xxii.

[4] 'Pal. Mem.,' ii, 1868, p. 525.

[5] 'Trans. Roy. Dublin Soc.,' (2), i, 1881, p. 208.

[6] 'Trans. Roy. Irish Acad.,' xxxiii (1906), B, pt. 1, p. 41.

[7] 'Oss. Foss.,' ed. 2 (1823), iv, p. 467.

[8] 'Geschichte der Urwelt,' ii, p. 851.

[9] 'Quart. Journ. Geol. Soc.,' l (1894), p. 200.

[10] Ibid., lv (1899), p. 425.

[11] "Mon. Mamm. foss. de Lombardie," 'Pal. Lomb.,' ii (1870), p. 33, pl. xi.

[12] 'Sitzb. k. Akad. Wiss. Wien,' lxxxii, pt. 1 (1880), pl. ii, figs. 24—26, and ibid. lxxxviii, pt. 1 (1883), pl. ii, figs. 1, 2.

while Hensel[1] (1881) gave full figures and measurements of large recent skulls. Boule and Chauvet[2] (1899) alluded to the occurrence of the remains of a large polecat among an Arctic fauna described by them from the Charente.

All these authors agree in referring the large skulls to the recent species of polecat, *Mustela putorius*.

Newton was the first to propose a distinctive name for this large form. He, however, thought it possible that the Ightham form might be the same as that to which Meyer[3] gave the name *Mustela antiqua*. The latter author's use of the name is, however, unaccompanied by any description, and he does not indicate that he intended to apply it to large forms of the polecat.

The splendidly preserved cranium figured in the present memoir (Pl. I, figs. 7—9) was obtained by Mr. W. J. Lewis Abbott from the Ightham fissure in 1907. A comparison of this skull with skulls of *Mustela martes* in the British Museum and Bristol University collection shows that there are a number of obvious points of difference. *Mustela robusta* differs from *Mustela martes* in (1) the width and shortness of the palate; (2) the shortness antero-posteriorly of $\overline{\text{m. 1}}$; (3) the absence of $\underline{\text{pm. 1}}$; (4) the less inflated character of the auditory bulla; and (5) the somewhat more flattened character of the cranial roof. The skull is clearly that of a polecat, the only appreciable difference from *Mustela putorius* being in point of size.

Mustela putorius, THE POLECAT.

The records of the occurrence of the polecat in British Pleistocene deposits are very scanty. Owen[4] figured a skull from Berry Head, and mentioned that an almost entire skull had been found in a raised beach near Plymouth. Falconer[5] recorded it from Bacon Hole, Long Hole, and Spritsail Tor, Gower, and Newton[6] from the Ightham fissure. The British Museum contains a considerable number of bones from the Brixham cave, and a few have been obtained by the Rev. E. H. Mullins at Langwith.

Of the continental records the following may be alluded to: Cuvier described[7] some musteline bones which de Blainville[8] referred to the polecat. Schmerling[9] figured a good cranium and mandible from Liège. Krüger[10] referred to polecat

1 "Craniologische Studien," 'Nova Acta Acad. Caes. Leop.,' xlii (1881), pl. vi, figs. 1, 2.

2 'Comptes Rendus,' cxxviii (1899), p. 1188.

3 'Palæologica,' 1832, pp. 54, 130.

4 'Brit. Foss. Mamm. and Birds,' p. 112.

5 'Pal. Mem.,' ii, p. 525.

6 'Quart. Journ. Geol. Soc.,' lv (1899), p. 425.

7 'Ann. Mus.,' xx, p. 437, and subsequently 'Oss. Foss.,' ed. 2 (1823), p. 467.

8 'Ostéographie—Mustela,' p. 57.

9 'Recherches Oss. Foss. Cavernes de Liège,' ii, pl. i.

10 'Geschichte der Urwelt,' p. 851.

remains from Gailenreuth. The descriptions of the bones of polecats by Cornalia (1870), Woldrich (1880 and 1883), Hensel (1881), Boule and Chauvet (1899), have been sufficiently dealt with under the head of *Mustela robusta*, and need not be repeated here.

Mustela erminea, THE STOAT OR ERMINE.

The fact of the stoat being a member of the British Pleistocene cave-fauna was established by Owen,[1] who figured a skull from Berry Head, near Brixham. The teeth and larger of the jaws figured by Buckland[2] from the Kirkdale cave as weasel, were shown by Owen[1] to be those of the stoat. It was obtained by McEnery[3] from Kent's Hole, Torquay, and by Falconer[4] from Bacon Hole, Gower, while Scharff recorded it from the Kesh[5] caves, co. Sligo, and the Newhall and Edenvale[6] caves, co. Clare.

Early continental records of the occurrence of *Mustela erminea* are, to say the least, very scanty. Neither Cuvier, de Blainville, nor Schmerling refer to it. Liebe[7] (1879) records it from Vypustek, Woldrich[8] (1882, 1884, 1888) from Zuzlawitz, Winterfeld[9] (1886) from O. Ruzsin, in Hungary.

Mustela vulgaris, THE WEASEL.

Though it cannot be doubted that the remains of the weasel have occurred in many British Pleistocene deposits, the records are very scanty. Buckland[10] recorded it from the Kirkdale cave, but, as Owen[11] pointed out, the teeth and jaws figured by him are in the main too large for the weasel, and should be attributed to the stoat. The smallest mandible figured ('Rel. Div.,' pl. xxiii, fig. 12) may belong to the weasel. McEnery[12] figured a skull from Kent's cave, which he attributed to the weasel, and de Blainville[13] assented as to the correctness of this determination; Owen,[14] however, attributed McEnery's specimen to the stoat, and in this was

[1] 'Brit. Foss. Mammals and Birds' (1846), p. 116 et. seq.

[2] 'Reliq. Diluv.' (1824), pl. vi, figs. 28, 29, and pl. xxiii, figs. 11, 13.

[3] 'Cavern Researches' (1859), pl. E, fig. 17.

[4] 'Pal. Mem.' (1868), p. 525.

[5] 'Trans. Roy. Irish Acad.,' xxxii, B, pt. 4, p. 205.

[6] Ibid., xxxiii, B, pt. 1, p. 40.

[7] 'Sitzb. k. Akad. Wiss. Wien,' lxxix, pt. 1, p. 477.

[8] Ibid., lxxxii, pt. 1, p. 35; lxxxiv, pt. 1, p. 199; and lxxxviii, pt. 1, p. 997.

[9] 'Ueber quartäre Mustelidenreste Deutschlands' (1886), p. 25.

[10] 'Reliq. Diluv.,' table facing p. 1 and description of pls. vi and xxiii (1824).

[11] 'Brit. Foss. Mamm. and Birds' (1846), p. 117.

[12] 'Cavern Researches' (1859), pl. E, fig. 17.

[13] 'Ostéographie—Carnassiers, Mustela,' p. 59.

[14] 'Brit. Foss. Mamm. and Birds' (1846), p. 117.

followed by Woodward and Sherborn.[1] Owen gives no special account of the weasel in his 'British Fossil Mammals and Birds,' and it is not included by Dawkins in his list of British post-glacial Mammalia. Passing to the continental records: Schmerling[2] figured a musteline cranium and mandible which he did not venture to name, but which agreed in point of size with the weasel. Woldrich,[3] in each of his three papers on the 'Diluvial Fauna of Zuzlawitz,' described bones of the weasel, referring very small specimens to a new species under the name of *Fœtorius minutus*.

Newton[4] recorded skulls and limb-bones from the Ightham fissure both of the common weasel and of a smaller variety, which he, following Woldrich,[5] referred to under the specific name of *minuta*. It is represented in the Manchester Museum by an imperfect mandible from Creswell Crags, and by other remains from Dog Holes, Warton Crag, Lancashire.

Gulo luscus, THE GLUTTON.

The earliest recognition of the glutton as a member of the Pleistocene fauna is due to Goldfuss[6] who in 1818 gave a good figure of an almost perfect skull from Gailenreuth, seeking to make of it a new species under the name of *Gulo spelæus*. At a later date he obtained a specimen from Sundwig to which he referred in his 'Säugethiere der Vorwelt,' 1823 (p. 481). Soemmering also procured a very well-preserved skull from Gailenreuth, which he submitted to Cuvier, who gave a reduced figure of it.[7] Schmerling[8] obtained only teeth, a femur and part of a pelvis from the caverns of Liège.

The remains of the glutton found in Britain are rare and fragmentary. They are first met with in the Forest Bed, part of a left mandibular ramus having been described by Newton[9] from Mundesley. It has been recorded from a considerable number of Pleistocene caves. The earliest record is that of Bellamy[10] from Yealm Bridge, Devon, confirmed by Pengelly[11] in 1871.

1 'Catal. Brit. Foss. Vertebrata' (1890), p. 368.

2 'Recherches Oss. Foss. Cavernes de Liège,' ii, pl. i, figs. 4—6.

3 'Sitzb. k. Akad. Wiss. Wien,' lxxxviii (1884), pt. i, p. 1000.

4 'Quart. Journ. Geol. Soc.,' lv (1899), p. 425.

5 Ibid., l (1894), p. 201.

6 'Nova Acta Acad. Caes. Leop.,' ix (1818), p. 311, pl. viii. The mandibular ramus attributed by Goldfuss to a *Viverra* and figured by him ('Die Umgebungen von Muggendorf,' v, 1810, 3) is assigned by Schmerling to a marten or polecat ('Cavernes de Liège,' ii, p. 5) and by de Blainville ('Ostéographie—Carnassiers, Mustela,' p. 53) to the glutton.

7 'Oss. Foss.,' ed. 2, 1825, pl. xxxi, figs. 23—25.

8 'Recherches Oss. Foss. Cavernes de Liège,' i, p. 167.

9 'Geol. Mag.' [2] vii, 1880, p. 424, pl. xv, and "Vert. Forest Bed" ('Mem. Geol. Surv.,' 1882), p. 17, pl. vi.

10 'Nat. Hist. S. Devon,' pp. 89, 94, 102.

11 'Trans. Devon. Assoc.,' iv, 1871, pp. 98, 102.

Dawkins and Sanford[1] (1866) include it in their list of Pleistocene mammals on the evidence of the crowns of three canine teeth obtained from the caves of Bleadon and Banwell, Somerset, and from one of the Gower caves (see Text-fig. 1, C, D, and E, for the Somerset specimens). It is not, however, mentioned by Falconer[2] in his list of the Gower cave-fauna, and Woodward and Sherborn[3] do not include Gower as one of the localities where its remains have been met with. Dawkins[4] in 1871 described a left mandibular ramus from the Plas Heaton cave, Cefn, near S. Asaph, this fine specimen, which is shown in Text-fig. 1, A, being now preserved in the Grosvenor Museum, Chester. Finally, in 1875 Busk[5] added Creswell Crags to the list of localities, though the determination was based only on two fragments of pelvis (see Text-fig. 2).

A comparatively recent continental record of the occurrence of the glutton is by Liebe[6] (1879) from Vypustek in Moravia. Winterfeld[7] (1886) discussed its distribution, and gave some German records of its occurrence in loess and other deposits.

Meles taxus, THE BADGER.

The remains of the badger were discovered in Pleistocene caves at an early date, and have been recorded from a very large number, though, perhaps, not from so many as the habits of the animal would lead one to expect.

The earliest records of the badger from Pleistocene deposits are by Schmerling[8] (1833), who gave good figures of the skull and limb-bones from the caves of Liège, and by Münster[9] (1836), who described it from the neighbourhood of Baireuth.

Both these authors regarded their species as distinct from the modern species, Schmerling referring to his as *Meles antediluvianus* and Münster to his as *Meles antiquus*.

M. de Serres, Dubrueil and Jeanjean[10] in 1839 figured a skull and other bones from Lunel Viel, and affirmed the identity of the badger of the caves with the recent species, a point concerning which subsequent writers have been unanimous.

1 "British Pleistocene Mammalia" ('Pal. Soc.,' 1866), pt. 1, p. 21.

2 'Pal. Mem.,' ii, 1868, p. 525.

3 'Catal. Brit. Foss. Vertebrata,' 1890, p. 350.

4 'Quart. Journ. Geol. Soc.,' xxvii, 1871, p. 406.

5 Ibid., xxxi, 1875, p. 687.

6 'Sitzb. k. Akad. Wiss. Wien.,' lxxix, 1879, pt. 1, p. 476.

7 'Ueber quartäre Mustelidenreste Deutschlands,' 1886, p. 40.

8 'Recherches Oss. foss. Cavernes de Liège,' i, 1833, p. 158.

9 'Verzeichniss der Versteinerungen . . . zu Baireuth,' 1836, p. 87.

10 'Recherches Oss. humatiles Cavernes de Lunel Viel,' 1839, pl. i.

Nordmann[1] in 1847 recorded it from Odessa, and McEnery, as reported by de Blainville[2] (1844) from Kent's Cave, Torquay. Owen[3] (1846) figured

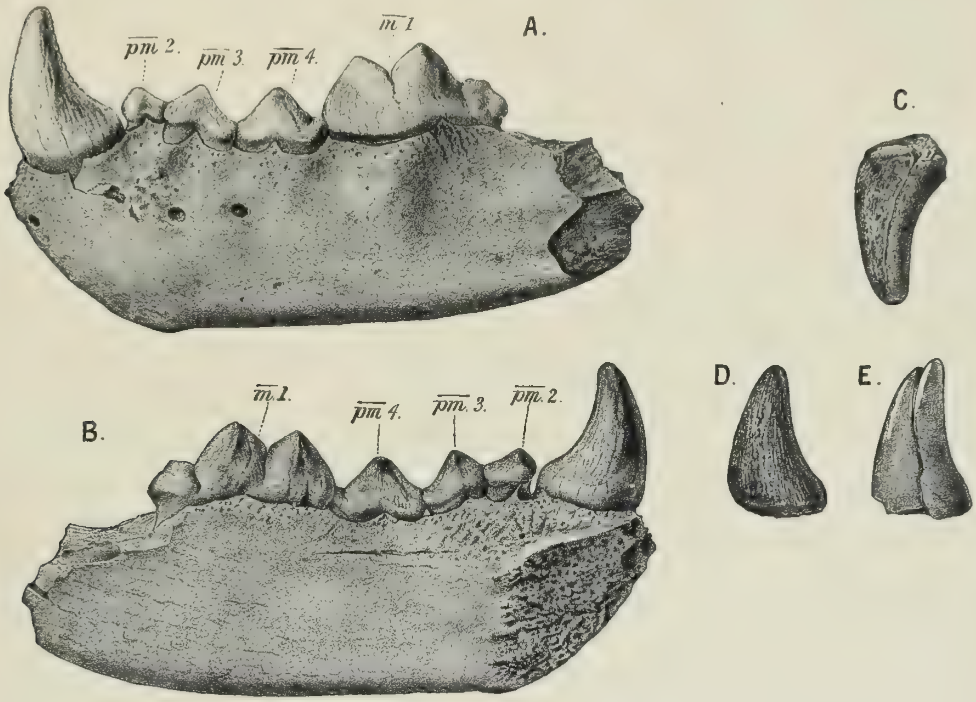


Fig. 1.—Glutton (*Gulo luscus*). A. Left mandibular ramus seen from the outer side. B. The same seen from the inner side. From the Pleistocene of the Plas Heaton Cave, Cefn, near St. Asaph (Grosvenor Museum, Chester). C. Crown of left upper canine. From the Pleistocene of the Bleadon Cave, Somerset (Taunton Museum). D. and E. Crowns of left lower canines. From the Pleistocene of Banwell Cave, Somerset (Taunton Museum). All three teeth seen from the outer side. Nat. size.

Fig. 2.—Glutton (*Gulo luscus*). Busk's figure of a fragmentary innominate bone from the Pleistocene of Creswell Crags. Reproduced by permission of the Council of the Geological Society. Nat. size.

1 'Découv. Gîtes riches en Oss. foss. Odessa,' p. 4.

2 'Ostéographie,' fasc. 4.

3 'Brit. Foss. Mamm. and Birds,' p. 109.

McEnery's specimen—a well-preserved mandible, now in the British Museum. He also recorded the badger from Berry Head.

H. von Meyer[1] (1859) described remains of the badger from the neighbourhood of Weimar, giving a number of references to French and other records.

Dawkins and Sanford[2] (1866) recorded it from Banwell and Wookey Hole, and Falconer[3] (1868) from a number of the Gower caves. Other records are from the caves or fissures of Durdham Down,[4] Uphill,[5] Ightham,[6] Cefn[7] (near St. Asaph), and Hoe Grange.[8]

Pleistocene deposits other than caves have yielded bones of the badger at Newbury, Berkshire, and Grovehurst, Kent, though the age of the latter deposit is somewhat doubtful.

Adams[9] records it from Ballynamintra, co Waterford, and Scharff[10] from the Edenvale, Newhall and Barntick caves, co. Clare.

The remains of the badger were remarkably abundant in the Langwith cave, near Mansfield, and included the remarkably elongated skull figured in Pl. V.

Lutra vulgaris, THE OTTER.

Owen[11] referred to a mandible of this animal as having been found in the Norwich Crag at Southwold, and to a humerus found in the same beds at Aldborough, but Newton[12] was unable to see the specimens and verify the record. He, however, recorded[13] it from the Forest Bed of East Runton. He further believed that an otter occurred in Britain in Red Crag times, referring[14] to de Blainville's species *Lutra dubia*, a specimen from the Red Crag of Foxhall, near Woodbridge, which differed from *Lutra vulgaris* in having the carnassial tooth longer from before backwards, and narrower than in the recent species, while

1 'Palæontographica,' vii, 1859, pp. 41—45.
2 "British Pleistocene Mammalia" ('Pal. Soc.,' 1866), pt. 1, p. xxii.
3 'Pal. Mem.,' ii, p. 525.
4 'Proc. Bristol Nat. Soc.,' N.S., v, 1885—88, p. 44.
5 Ibid., N.S., ix, 1898—1900, p. 159.
6 'Quart. Journ. Geol. Soc.,' lv, 1899, p. 428.
7 'Geol. Mag.' [3] iii, 1886, p. 571.
8 'Quart. Journ. Geol. Soc.,' lxi, 1905, p. 50.
9 'Trans. Roy. Dublin Soc.' [2] i, 1881, p. 208.
10 'Trans. Roy. Irish Acad.,' xxxiii, B., pt. 1, p. 42.
11 'Brit. Foss. Mamm. and Birds,' p. 119.
12 'Geol. Mag.' [3] iv, 1887, p. 145.
13 'Quart. Journ. Geol. Soc.,' xlvi, 1890, p. 444.
14 "Vert. Pliocene Deposits" ('Mem. Geol. Surv.,') p. 12.

the inner tubercle is also smaller. The specimen further differs from *Lutra vulgaris* in that each of the premolars has the posterior root much longer in proportion than the anterior. In the same memoir (p. 13) Newton described a new

1. TABLE SHOWING THE DISTRIBUTION OF MUSTELIDÆ IN THE PLEISTOCENE DEPOSITS OF THE BRITISH ISLES.

	Marten (*Mustela martes*).	Giant polecat (*Mustela robusta*).	Polecat (*Mustela putorius*).	Stoat (*Mustela erminea*).	Weasel (*Mustela vulgaris*).	Glutton (*Gulo luscus*).	Badger (*Meles taxus*).	Otter (*Lutra vulgaris*).
Pliocene deposits	+					+	+	
PLEISTOCENE	CAVES	AND	FISSURES.					
Bacon Hole, Gower	...	...	+	+	.		+	
Ballynamintra, co. Waterford	+	...	...	...			+	..
Banwell	...	...	...	...	...	+	+	+
Barntick, co. Clare	+	...	...	...	...	..	+	
Bench	...	...	...				+	
Berry Head	...	...	+	+	...		+	
Bleadon	+	...	...	...	...	+	...	+
Brixham	...	...	+	+	+ ?	...	...	
Cefn, near St. Asaph						+	+	
Creswell Crags	...	...	..		+	+	...	
Dog Holes, Warton Crag	...	...	...	...	+	...	+	..
Durdham Down							+	+
Edenvale, co. Clare	...	...	...	+			+	
Grays Thurrock, Essex	...	...	...	...	...	..	...	+
Happaway, Torquay	+ ?	...	+	...	...	...	+	
Hoe Grange, near Matlock	...	..					+	
Ightham	...	+	+		+		+	..
Ipswich	...	...	...	...	...		.	+
Kent's Cave, Torquay	...	...	...	+	+		+	+
Kesh, co. Sligo	...	...	..	+				
Kirkdale	...	...	..	+ ?	+ ?			
Langwith Bassett, near Mansfield	+	...	+	..	+		+	+
Long Hole, Gower	+	.	+		.		+	+
Newhall, co. Clare	+	...	...	+	...	..	+	+
Oreston	...	...	...	+ ?	...	...		..
Plymouth (raised beach)	...	...	+	...	...	...	...	.
Ravenscliff, Gower	+				.		+	
Shandon	...	...	...	...	...		+	..
Spritsail Tor, Gower	+	...	+	...	...		+	..
Teesdale			.	...	...		...	+
Uphill						..	+	.
Wookey						...	+	..
Yealm Bridge, Devon						+		..

NOTE.—Some of the records from co. Clare are probably Prehistoric rather than Pleistocene.

species (*Lutra reevesi*), founding it on a right lower carnassial tooth which had not cut the jaw, from the Norwich Crag of Bramerton.

As is natural from the habits of the animal, the remains of the otter are scanty in caves, but more abundant in river-gravels and similar deposits. Marcel de Serres, Dubrueil and Jeanjean[1] described and figured a lower jaw from Lunel Viel, which they referred to a new species, and Croizet and Jobert[2] described bones from the Puy-de-Dôme district.

The only Post-Pliocene specimens referred to by Owen in his 'British Fossil Mammals and Birds' are from the peat and its associated marls of Cambridgeshire, and belong to the Prehistoric rather than to the Pleistocene fauna. Dawkins and Sanford[3] (1866) stated that the only Pleistocene remains of the otter with which they were acquainted were from Kent's Hole, Torquay, and Banwell Cave, and from the brick-earth of Gray's Thurrock, Essex. In Dawkins' paper[4] on the "Distribution of the British Post-glacial Mammals" (1869) the additional cave-localities of Durdham Down and Long Hole, Gower, were given, with Ipswich, as a river deposit. The otter occurs rarely in the Langwith Cave.

Scharff[5] recorded the otter from the Newhall Cave, co. Clare, this being the first notice of its occurrence in Ireland in Pleistocene strata.

III. DESCRIPTION OF THE SKELETON.

The Mustelidæ form a large and somewhat heterogeneous group of Carnivores, and are grouped with the Ursidæ and Procyonidæ in the section Arctoidea.

The cranial part of the skull tends to be considerably elongated and somewhat sharply marked off from the facial portion. The glenoid cavity is relatively far forward. The Mustelidæ agree with the Felidæ and Hyænidæ, and differ from the great majority of the Ursidæ, Viverridæ, and Canidæ, in having no alisphenoid canal. The auditory bulla is not as a rule much inflated. The palate is generally considerably produced behind the last molars. The hamular process of the pterygoid is prominent. The infra-orbital foramen is generally very large, and the orbit communicates widely with the temporal fossa. The post-glenoid process tends to curve over the mandibular condyle, and sometimes holds the mandible attached to the cranium.

The dental formula in the great majority of cases is i. $\frac{3}{3}$, c. $\frac{1}{1}$, pm. $\frac{3-4}{3-4}$, m. $\frac{1}{2}$. In

[1] 'Recherches Oss. humatiles Cavernes de Lunel Viel,' p. 70, pl. ii, figs. 14, 15.

[2] 'Oss. foss. Dept. Puy-de-Dôme,' p. 89.

[3] 'British Pleistocene Mammalia" ('Pal. Soc.,' 1866), pt. 1, p. xxii.

[4] 'Quart. Journ. Geol. Soc.,' xxv, 1869, p. 198.

[5] 'Trans. Roy. Irish Acad.,' xxxiii, B. pt. 1, p. 41.

rare cases the molars may number $\frac{1}{1}$ or $\frac{2}{2}$. The upper carnassial, pm. 4, differs from that in Ursidæ and resembles that in Felidæ, Hyænidæ, and Canidæ, in possessing a more or less antero-internally placed inner tubercle supported by a distinct root.

A. The Skull.

Mustela.—The cranial portion of the skull is not so sharply marked off from the facial as in *Meles* and *Lutra*. The sagittal and superciliary crests are less developed than in *Meles*; the occipital crest on the other hand is commonly very strong. The post-orbital processes of the frontal and jugal are fairly prominent, and sometimes approach one another, especially in *Mustela erminea*. The foramen magnum is of relatively large size. The auditory bulla is considerably inflated. The infra-orbital foramen is smaller in proportion to the size of the cranium than in *Lutra* and *Meles*, and the post-glenoid process is not sufficiently recurved to hold the mandible attached to the cranium.

Gulo.—The cranial portion of the skull is more strongly marked off from the facial than in *Mustela*, but less so than in *Lutra*. There is a greater development of ridges, especially of the sagittal crest, than in any other British member of the Mustelidæ, except *Meles*. The jaws are very powerful. The foramen magnum is of relatively smaller size than in *Mustela*, and the auditory bulla, though variable, is less inflated. The paroccipital process of the exoccipital is prominent, while the post-orbital process of the jugal is very slightly developed. The post-glenoid process is much incurved, and holds the mandible firmly attached to the cranium.

Meles.—The skull of the common badger bears a very close resemblance to that of the glutton in general form, development of ridges, strength of jaws, and relative size of the foramen magnum. Also in the development of the paroccipital process of the exoccipital and of the post-glenoid process, which attaches the mandible to the cranium perhaps even more firmly than in *Gulo*. The superciliary ridges are somewhat stronger than in *Gulo*, and the zygomatic arch is rather stouter.

Lutra.—The skull of the otter is of a peculiar character, broad and depressed, with the cranial portion, which is much expanded posteriorly, sharply marked off from the facial portion by a strong constriction behind the orbits. The sagittal and superciliary ridges are but slightly developed. The infra-orbital foramen is very large, and the post-glenoid process is not so much recurved as in *Meles*. The ventral surface of the cranial portion of the skull is notably broad and flattened, and the auditory bulla is very little inflated. The mandible is small and weak in comparison with that of *Meles*.

(1) TABLE OF COMPARATIVE MEASUREMENTS OF MUSTELINE SKULLS.

	Mustela martes, ? Prehistoric, Newhall Caves, Co. Clare (Nat. Mus., Dublin).	*Mustela foina* ♂, recent, S. Germany, No 1299B, (Brit. Mus.).	*Mustela robusta*, Pleistocene, Ightham, near Maidstone (Lewis Abbott Coll.).	*Mustela putorius* ♂, recent, Boncath, Cardiganshire, No. 0.10.9.1. (Brit. Mus.).	*Mustela putorius*, ? Prehistoric, Ightham near Maidstone (Corner Coll.).	*Mustela erminea*, Pleistocene, Berry Head, (Brit. Mus.).	*Mustela vulgaris*, Pleistocene, Ightham, near Maidstone (Lewis Abbott Coll.).	*Mustela vulgaris* var. *minuta*, Pleistocene, Ightham, near Maidstone (Corner Coll.).	*Gulo luscus* ♂, recent, Egersund, Norway, No. 10 11.26.1. (Brit. Mus.).	*Meles taxus*, Pleistocene, Grovehurst, Sittingbourne, No. M.1884 (Brit. Mus.).	*Meles taxus*, Pleistocene, Langwith, near Mansfield (Mullins Coll.).	*Meles taxus* var., Pleistocene, Langwith, near Mansfield (Mullins Coll.).	*Lutra vulgaris*, Prehistoric, Burwell Fen (Sedgwick Mus.).
1. Length from intercondylar notch to anterior end of skull	8·15	7·7	7·05	6·2	5·5	4·3	3·3	2·95	13·1	12·6	11 85	13 2	11·1
2. Extreme width across zygomatic arches	5·8	5·2	4·5	4·1	3·65	...	...	1·45	10·2	8 45	7·6	8·2	7·7
3. Height from suture between basi-occipital and basi-sphenoid to top of sagittal crest	3·0	2·7	2·3	2·05	2·0	1·45	1·1	1·0	5·3	4·6	4 25	4·15	3·6
4. Width at lachrymal foramen	2·2	2·1	2·0	1·75	1·55	1·2	·75	·7	4·1	3·45	3·3	3·4	2 65
5. Width between ends of post-orbital processes of frontal	3·0	2·7	2·15	2·1	2·1	1·35	·85	·8	4·65	3·7	3·55	3·5	2·25
6. Minimum width of cranium behind post-orbital processes	2·0	1·8	1·7	1·6	1·5	1·05	·75	·75	3·4	2·4	2·15	2·4	1·3
7. Width immediately behind zygomatic process of squamosal	3·75	3·8	3·3	2·95	2·8	2·05	1·55	1·3	8·1	5·8	5·1	5·3	5·8
8. Length of face from point midway between post-orbital processes of frontal to narial opening	2·2	2·3	2·1	1·8	1·45	1·3	·95	·95	3 65	4·55	4·25	4·65	2·35
9. Length of palate measured to alveolus of i. 1	4·3	4·0	3·35	3·0	2·7	1·9	1·3	1·1	7·3	7·4	6·85	7·85	5 05
10. Transverse diameter of foramen magnum	1·3	1·2	1·15	·85	·9	·65	·5	·45	1·65	1·7	1·5	1·5	1·5
11. Length of mandibular ramus measured to end of condyle	...	5·4	4·55	4·05	...	2·6	1·8	1·5	10·25	9·25	...	...	7·5

B. THE DENTITION.

MUSTELA.—Dental formula—i. $\frac{3}{3}$, c. $\frac{1}{1}$, pm. $\frac{3}{3}$–$\frac{4}{4}$, m. $\frac{1}{2}$.

Permanent Dentition of the Upper Jaw.—I. 1 and 2 are very small, one-rooted, simple teeth, i. 3 is a larger and caniniform tooth. The canine is a relatively very large tooth with a long slightly recurved crown. Pm. 1 is a very small one-rooted tooth which, while present in *Mustela martes* and other representatives of the genus *Martes* of Nilsson, is absent in *M. putorius, M. robusta, M. erminea* and *M. vulgaris*, representatives of the genus *Putorius* of Nilsson. Pm. 2 and 3 are simple conical teeth with two roots and a rather well-marked cingulum. Pm. 4, the carnassial, is a large tooth with a prominent blade consisting of a larger anterior and a smaller posterior lobe. The cingulum is well developed, and there is a prominent inner tubercle near the anterior border of the tooth. M. 1, which is as large a tooth as pm. 4, is short, but very wide, with a raised outer portion bearing several small, ill-defined cusps, and a depressed and more flattened inner portion terminated by a raised semicircular inner border.

Permanent Dentition of the Lower Jaw.—I. 1, 2 and 3 are all very small teeth, their crowns being only from a quarter to a third as long as that of the canine, which is somewhat sharply recurved. Pm. 1 is a small, simple, one-rooted tooth, and like pm. 1, is absent in *Putorius*. Pm. 2, 3 and 4 are all very similar teeth with two roots and conical crowns. In pm. 3, and still more in pm. 4, there are indications of a slight additional cusp on the posterior edge of the main cusp. M. 1 is a large tooth with a bilobed trenchant blade and a depressed posterior portion or talon only half the length of the blade. M. 2 is a small one-rooted tooth with a rounded crown.

GULO.—Dental formula—i. $\frac{3}{3}$, c. $\frac{1}{1}$, pm. $\frac{4}{4}$, m. $\frac{1}{2}$.

Permanent Dentition of the Upper Jaw.—I. 1 and 2 are relatively powerful teeth, rather sharply curved downwards, with edges of a somewhat chisel-shaped character and indications of slight lateral cusps. I. 3 is a large caniniform tooth with a strongly marked cingulum, which passes obliquely along the inner face of the tooth, ending in a slight cusp not far from the point. C. is of the usual character, and powerful, but not specially large. Pm. 1 is a simple, conical, one-rooted tooth. Pm. 2 is two-rooted, and has the apex of the crown placed far forward. Pm. 3 is a very powerful two-rooted tooth with a rather low conical crown. Pm. 4, the carnassial, is a large tooth with a prominent bilobed blade supported by two roots, the anterior lobe being the larger. The inner tubercle, which is supported by a third root, is small and depressed, but very sharply marked off from the rest of the tooth. There is a fairly prominent cingulum which is raised into a slight cusp at the anterior end of the tooth. M. 1 is a rather large tooth transversely placed. A depression divides it into an outer portion supported by two roots and

raised into three ill-defined cusps, and an inner somewhat larger portion with a low cusp and a raised inner border.

Permanent Dentition of the Lower Jaw.—I. 1, 2 and 3 are relatively powerful teeth not differing greatly in size, though i. 3 has the crown somewhat expanded; i. 2 arises from the jaw at a point behind i. 1 and i. 3. C. is a powerful tooth with a somewhat prominent cingulum, which often gives off a ridge running along the inner face of the tooth to the apex. Pm. 1 is a small one-rooted tooth with a circular crown. Pm. 2, 3 and 4 are powerful two-rooted teeth increasing progressively in size. The crown is conical, and the apex, central in pm. 4, is further forward in pm. 3 and still further forward in pm. 2. M. 1 is a powerful tooth with a large blade, consisting of two equal-sized trenchant lobes and a small depressed talon. M. 2 is a small tooth with an oval crown not raised into any prominent cusps.

Meles.—Dental formula—i. $\frac{3}{3}$, c. $\frac{1}{1}$, pm. $\frac{4}{4}$, m. $\frac{1}{2}$.

Permanent Dentition of the Upper Jaw.—I. 1 and i. 2 are simple teeth with somewhat chisel-shaped blades, i. 3 is more caniniform. The contrast in size between i. 3 and c. is not so great as in *Lutra*. Pm. 1 is a very small tooth which almost always falls out at an early period. As a rule its alveolus is completely closed in old animals. Pm. 2 and 3 are simple, conical, two-rooted teeth. Pm. 4, the carnassial, has a prominent blade with a large conical anterior lobe and an ill-defined and often scarcely recognisable posterior lobe. The inner tubercle is large and depressed and not so much anteriorly placed as in *Mustela*, or so sharply marked off as in *Gulo*. M. 1 is a very large tooth with a broad surface covered by a series of small tubercles, which rise to form two rather prominent cusps at the antero-external border. This tooth has three roots.

Permanent Dentition of the Lower Jaw.—The lower incisors are simple teeth of the same character as those in the upper jaw. The canine has a thickened base to the crown, which is somewhat sharply recurved. Pm. 1 is very small, and early falls out; pm. 2, 3, and 4, are simple conical two-rooted teeth. M. 1 is a long and relatively very large tooth. The anterior half has a rather ill-defined bilobed blade, with a cusp placed internal to the posterior lobe. The posterior half has a somewhat depressed middle portion surrounded by a series of low cusps. M. 2 is a small one-rooted tooth, bearing several slight elevations on the crown.

Lutra.—Dental formula—i. $\frac{3}{3}$, c. $\frac{1}{1}$, pm. $\frac{4}{3}$, m. $\frac{1}{2}$.

Permanent Dentition of the Upper Jaw.—I. 1 and i. 2 are small cylindrical teeth; i. 3 is somewhat larger and more caniniform, but the canine, which is a rather long and slender tooth, contrasts strongly in point of size with the incisors. Pm. 1 is a very small simple tooth, and often falls out early. Pm. 2 and 3 are simple conical two-rooted teeth. Pm. 4, the upper carnassial, has a trenchant blade, with one very prominent principal lobe and a somewhat smaller posterior lobe. The

inner tubercle is large and depressed, with a sharp raised edge. M. 1 is a large, somewhat irregular tooth, broader than long, with two cusps on the outer edge, divided by a depression from two on the inner border.

Permanent Dentition of the Lower Jaw.—I. 1 is very small; i. 2 and 3 are slightly larger, but are very simple one-rooted teeth. The canine, as in the upper jaw, is greatly larger than the incisors. Pm. 2, 3 and 4 are simple, conical, two-rooted teeth, the cone in pm. 2 being obliquely truncated in front. M. 1, the carnassial, is a relatively large tooth, somewhat variable in character. The posterior half, or talon, is depressed; the anterior half bears two trenchant lobes, with a large tubercle internal to the posterior lobe. The cingulum is prominent in m. 1 and all the lower premolars. M. 2 is a rather small square tooth, with a flattened crown and a single root.

c. The Vertebral Column.

The numbers of the vertebræ are as follows:

	Cervical.	Thoracic.	Lumbar.	Sacral.	Caudal.
Mustela	7	14	6	3	18—33
Gulo	7	15	5	3	14 or 15
Meles	7	15	5	3	18
Lutra	7	14—15	5—6	3	25—26

There is little in the vertebral column of the Mustelidæ which demands special comment, but allusion may be made to the following points:

(1) The length of the tail in *Lutra*.

(2) The relatively large size of the atlas vertebra in *Lutra* and *Mustela*.

(3) The length of the spines of the anterior thoracic vertebræ of *Gulo*.

(4) The elongated character and shortness of the neural spines of the lumbar and posterior thoracic vertebræ of *Mustela*.

(5) The expanded character of the transverse processes of the lumbar vertebræ of *Lutra*.

d. The Limb Girdles.

The Pectoral Girdle.—The scapula shows a considerable amount of variation in shape and in the character of the acromion, which is always strongly developed, while the coracoid process is scarcely defined. In *Mustela*, *Gulo*, and *Lutra* there is a very large pre-scapular fossa and the coracoid border is gently curved. The supra-scapular border in *Gulo* and *Lutra* forms an angle not much less than a right angle with the spine. In *Mustela* the supra-scapular border is very short, and the

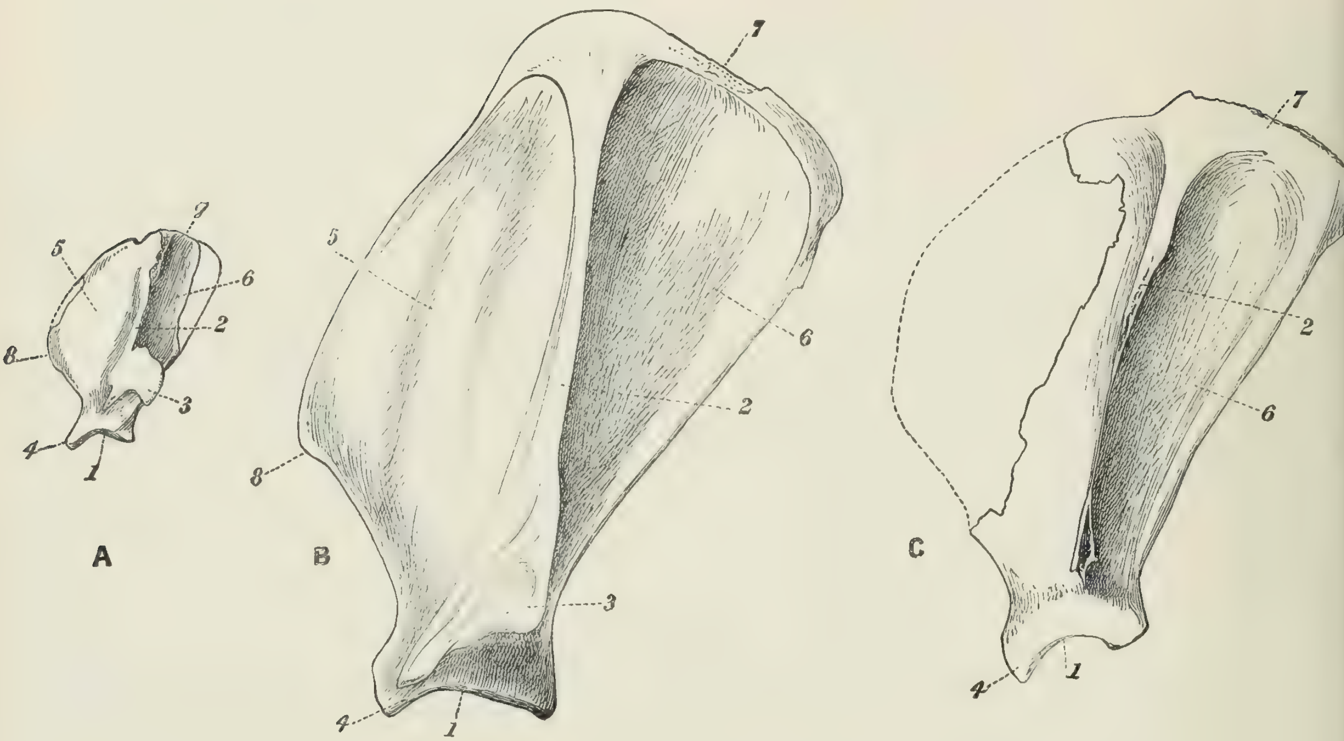


FIG. 3.—The left scapula seen from the outer side. A Polecat (*Mustela putorius*), from the Pleistocene of Ightham (Corner Coll.). B Badger (*Meles taxus*), from the Pleistocene of the Langwith Cave (Mullins Coll.). C Otter (*Lutra vulgaris*), from the Prehistoric peat of Burwell fen (Sedgwick Mus.). Natural size. 1, glenoid cavity; 2, spine; 3, acromion; 4, coracoid process; 5, pre-scapular fossa; 6, post-scapular fossa; 7, supra-scapular border; 8, coracoid border.

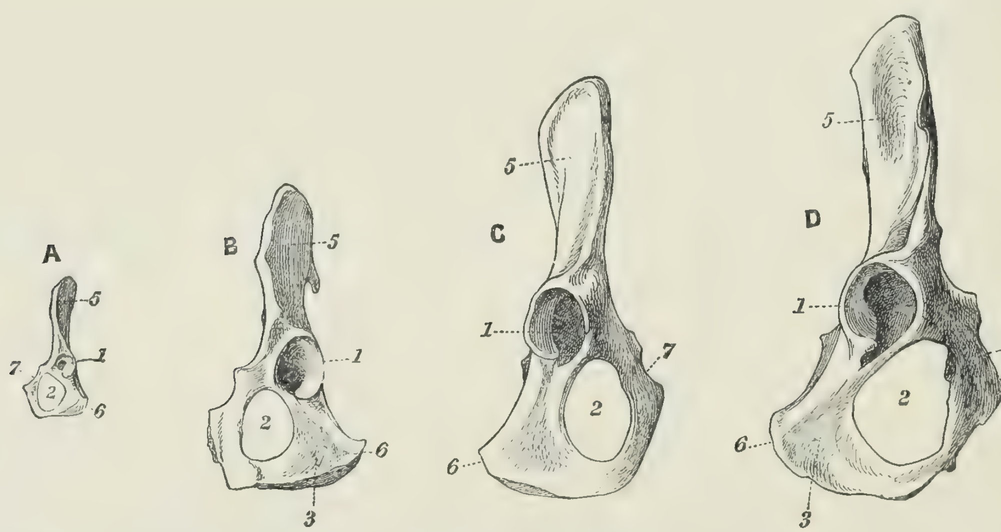


FIG. 4.—A Left innominate bone of a weasel (*Mustela vulgaris*). B left innominate bone of a stoat (*Mustela erminea*). Both from the Pleistocene of Ightham near Maidstone and preserved in Dr. F. Corner's collection. C right innominate bone of a giant polecat (*Mustela robusta*) from the Pleistocene of Ightham (Lewis Abbott Coll.). D right innominate bone of a marten (*Mustela martes*) from the ? Prehistoric deposit of the Edenvale Cave, co. Clare (National Mus., Dublin). Natural size. All bones seen from the ventro-external aspect. 1, acetabulum; 2, obturator foramen; 3, ischium; 4, sacral surface of ilium: 5, iliac surface of ilium; 6, tuberosity of ischium; 7, pubis.

post-scapular fossa is only about half as wide as the pre-scapular fossa at its widest. The scapula in *Meles* differs considerably in shape from those of the other members of the group, especially as regards the post-scapular fossa, which is about equal in size to the pre-scapular. The supra-scapular border forms an angle of about 60° with the spine, and the coracoid border is sharply angular. The development of the spine is greatest in *Meles* and *Lutra*, less in *Gulo*, and slight in

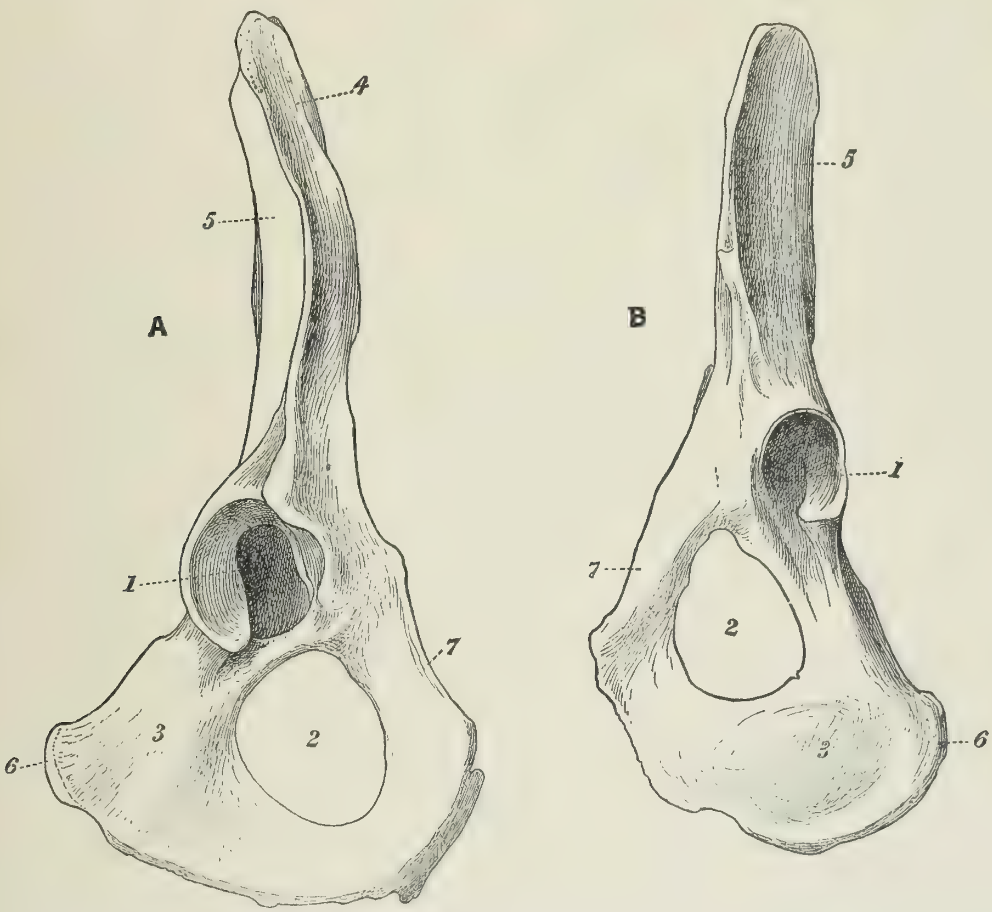


FIG. 5.—**A** right innominate bone of a badger (*Meles taxus*), from the Pleistocene of the Langwith Cave (Corner Coll.). **B** left innominate bone of an otter (*Lutra vulgaris*), from the Prehistoric peat of Roach Fen (Sedgwick Mus.). Both bones seen from the ventro-external aspect. Natural size. Lettering as in Fig 4.

Mustela. The acromion is prominent and sharply recurved in all four genera, but less in *Gulo* than in the others.

The Pelvic Girdle.—In *Mustela* and *Lutra* the pelvis is relatively weak and the ilium is little expanded. In *Gulo*, and still more in *Meles*, the ilium is considerably expanded. In *Gulo* the junction between the supra-iliac and acetabular borders of the ilium is gently rounded, while in *Meles*, it forms a prominent projection. The ischial tuberosity is more prominent in *Meles* than in *Gulo*.

(2) Tables of Comparative Measurements of the Limb Girdles.

	Meles taxus, Pleistocene, Langwith (Mullins Coll.).	*Lutra vulgaris*, Prehistoric, Burwell fen (Sedgwick Mus.).
Scapula.		
1. Length from coracoid process to end of spine	9·45	7·7
2. Length measured along glenoid border ...	7·55	6·0
3. Maximum diameter of neck	2·0	1·8

	Mustela martes, ? Prehistoric, Newhall, Co. Clare (Nat. Mus. Dublin).	*Mustela robusta*, Pleistocene, Ightham, nr. Maidstone (Lewis Abbott Coll.).	*Mustela putorius*, Pleistocene, Ightham, nr. Maidstone (Corner Coll.).	*Mustela vulgaris*, Pleistocene, Ightham, nr. Maidstone (Corner Coll.).	*Meles taxus*, Pleistocene, Langwith (Corner Coll.).	*Lutra vulgaris*, Prehistoric, Reach fen, Cambs. (Sedgwick Mus. Camb.).
Pelvic Girdle.						
1. Maximum length	6·1	5·35	3·9	1·8	11·0	10·4
2. Length from acetabulum to supra-iliac border of ilium ...	3·2	2·8	2·2	1·1	6·05	4·8
3. Dorso-ventral measurement of ilium at widest point	1·2	1·1	·9	·35	2·8	1·95
4. Antero-posterior diameter of acetabulum	·95	·8	·65	·25	1·7	1·3
5. Length from acetabulum to posterior border of ischium ...	2·05	1·8	1·35	·5	3·0	4·3
6. Maximum diameter of obturator foramen	1·7	1·35	1·0	·5	2·2	2·3

E. The Limbs.

These show a progressive decrease in relative length from *Gulo*, in which they are longest, through *Meles*, *Lutra*, and the larger members of the genus *Mustela* to *Mustela erminea* and *vulgaris*, in which they are very short. The limbs are sub-plantigrade in *Gulo*, *Meles* and *Lutra*, digitigrade in *Mustela*. The claws are strong (except sometimes in *Lutra*), and in *Mustela* are semi-retractile.

Anterior Limb.—The humerus in *Meles* and *Lutra* is a very powerful bone with strong deltoid and supinator ridges. An ent-epicondylar foramen is present in *Meles*, *Gulo* and *Mustela*, and may or may not be present in *Lutra*. In *Meles* the radius and ulna are also very short powerful bones, the lower end of the ulna bearing a prominent ridge on its inner side. The metacarpals tend to be shorter than the metatarsals, especially in *Lutra*.

Posterior Limb.—In *Mustela* this is considerably longer than the anterior, but the difference is less marked in the other genera. In *Meles* and *Lutra* the femur does not show such conspicuous ridges for the attachment of muscles as does the humerus of these animals. The fibula is slender, and stands somewhat widely away from the tibia except at the extremities. The metatarsals and digits are of greater relative length in *Gulo* than in *Meles*.

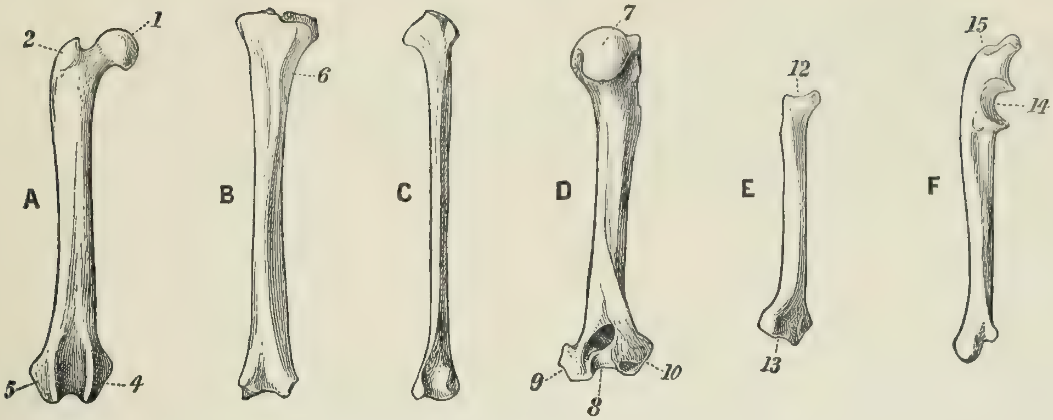


FIG. 6.—Limb bones of a polecat (*Mustela putorius*). A right femur; B left tibia; C right fibula (anterior view); D right humerus; E right radius (antero-external view); F right ulna (inner aspect). All from the Pleistocene of the Brixham Cave and preserved in the British Museum. In Text-figs. 6 to 10 the anterior aspect of the femur and tibia is shown, the posterior aspect of the humerus. Lettering of Text-figs. 6 to 10. 1, head of femur; 2, great trochanter; 3, third trochanter; 4, internal condyle of femur; 5, external condyle of femur; 6, cnemial crest; 7, head of humerus; 8, trochlea; 9, internal condyle of humerus; 10, external condyle of humerus; 11, ent-epicondylar foramen; 12, humeral articulating surface of radius; 13, carpal articulating surface of radius; 14, sigmoid notch; 15, olecranon. All figures of the natural size.

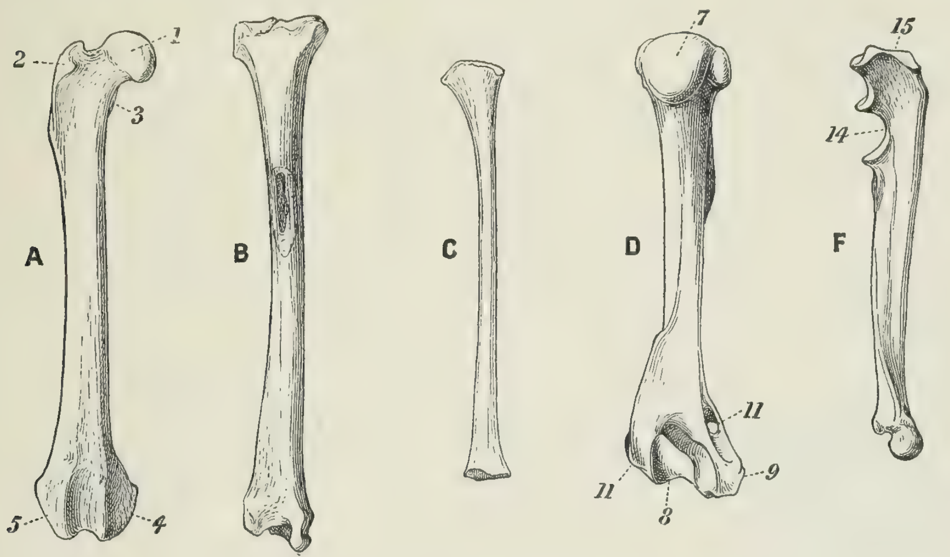


FIG. 7.—Limb bones of a giant polecat (*Mustela robusta*). A right femur; B right tibia; C right fibula (posterior aspect); D left humerus; F right ulna (inner aspect). All from the Pleistocene of the Ightham Fissure. The femur, tibia and humerus are preserved in the collection of Dr. F. Corner, the fibula and ulna in that of Mr. W. J. Lewis Abbott.

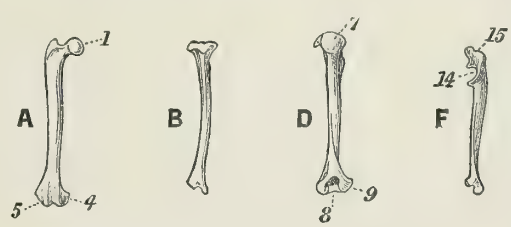


FIG. 8.—Limb bones of a weasel (*Mustela vulgaris*). A right femur; B right tibia; D left humerus; F left ulna (outer aspect). All from the Pleistocene of the Ightham fissure. The femur, humerus and ulna are preserved in the collection of Dr. F. Corner, the tibia in that of Mr. W. J. Lewis Abbott.

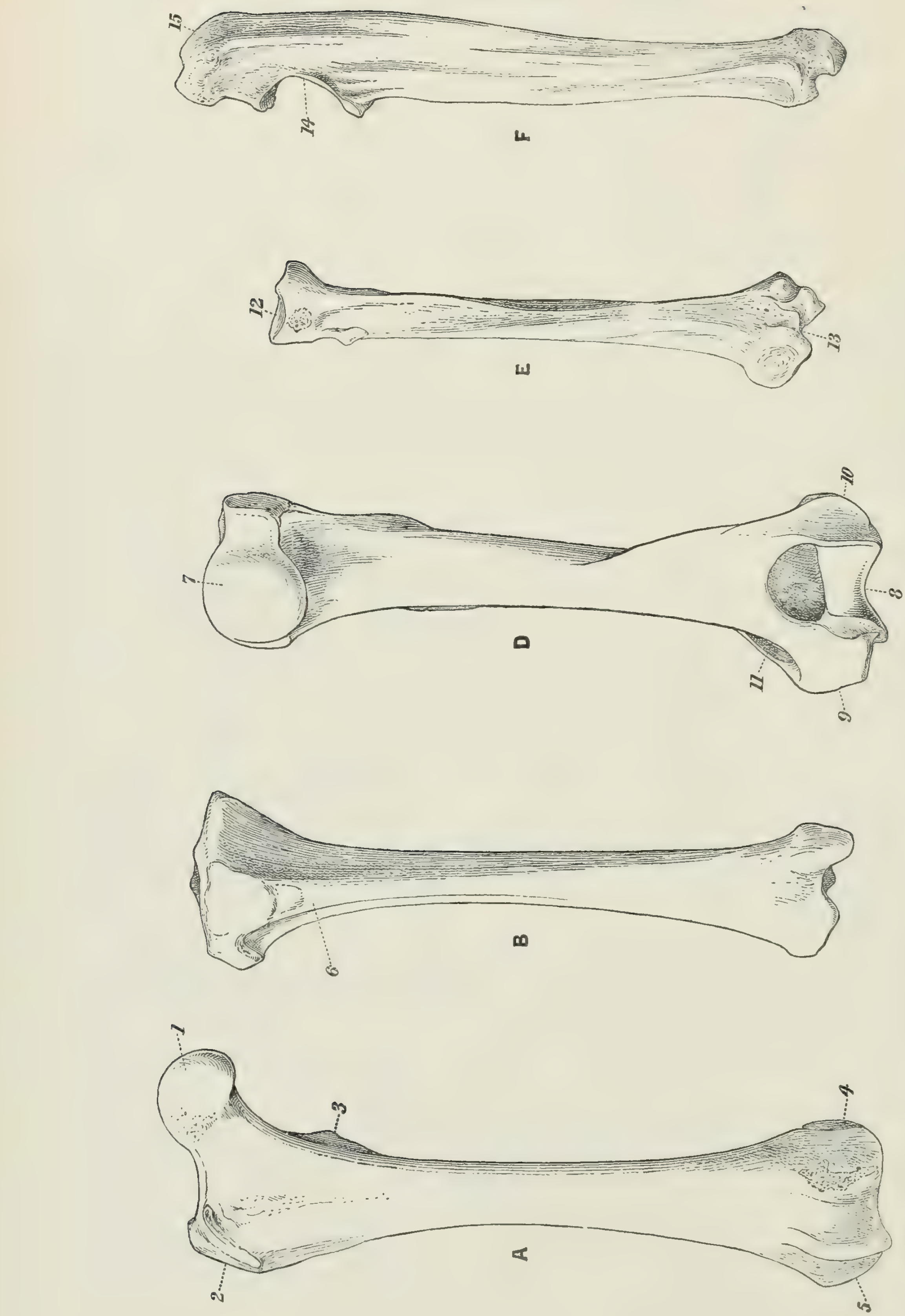


Fig. 9.—Limb bones of a badger (*Meles taxus*). **A** right femur. **B** right tibia. **D** right humerus. **E** right radius (antero-external view). **F** right ulna (inner aspect). All from the Pleistocene of the Happaway Cave and preserved in the British Museum.

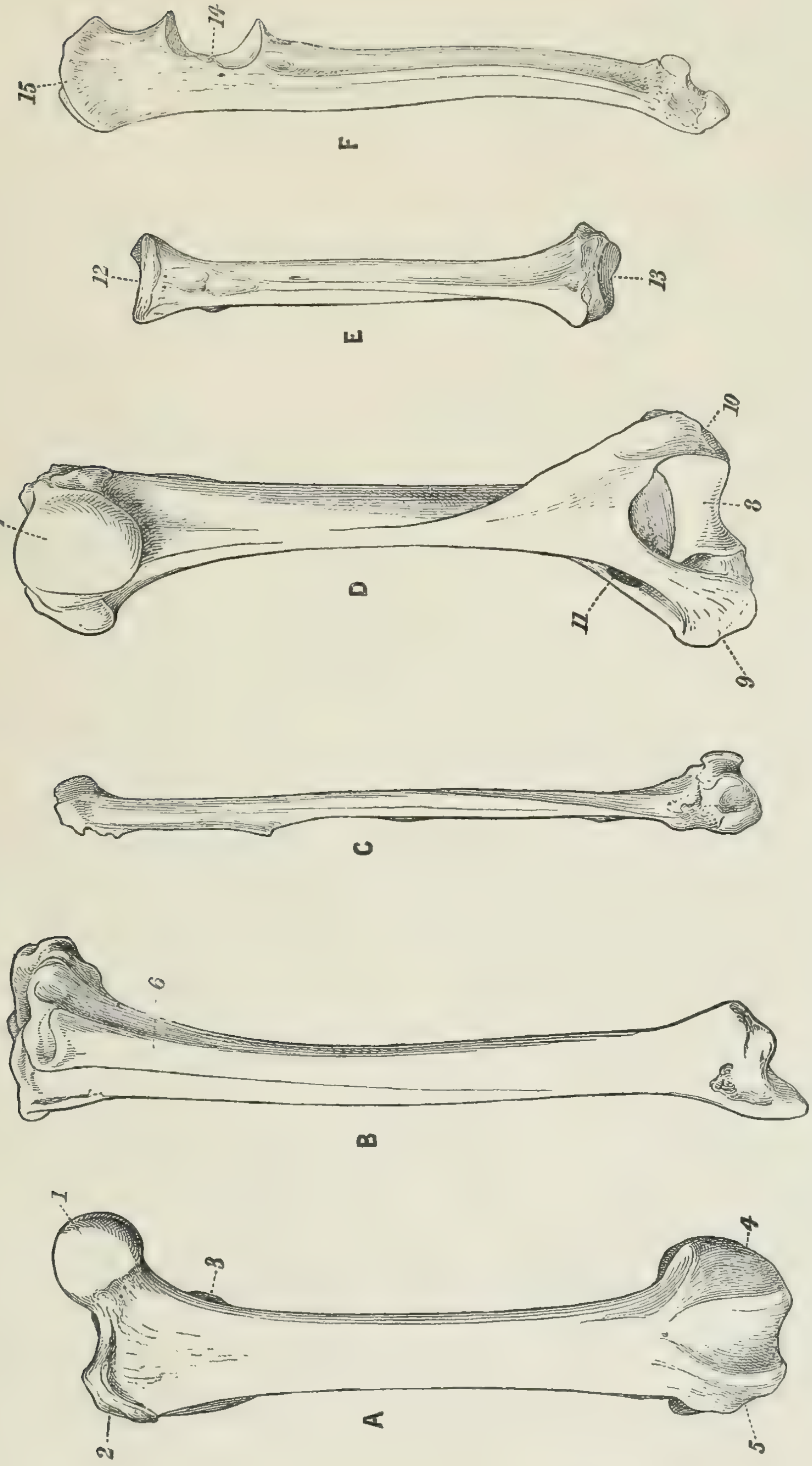


Fig. 10.—Limb bones of an otter (*Lutra vulgaris*). **A** right femur. **B** left tibia. **C** left fibula (outer aspect). **D** right humerus. **E** left radius (posterior aspect). **F** left ulna (inner aspect). All from the Prehistoric peat of Burwell Fen, and preserved in the Sedgwick Museum, Cambridge.

(3) Tables of Comparative Measurements of the Bones of the Anterior Limb.

	Mustela robusta, Pleistocene, Ightham, nr. Maidstone (Corner Coll.).	*Mustela putorius*, Pleistocene, Brixham, No. 48919 (Brit. Mus.).	*Mustela vulgaris*, var. *minuta*, Pleistocene, Ightham, nr. Maidstone (Corner Coll.).	*Meles taxus*, Pleistocene, Happaway, No. M. 5811 (Brit. Mus.).	*Lutra vulgaris*, Prehistoric, Burwell Fen, Camb. (Sedgwick Mus., Camb.).
Humerus.					
1. Length	5·7	4·2	2·0	11·5	9·4
2. Maximum diameter at distal end	1·5	1·05	·4	3·3	3·15

	Mustela putorius, Pleistocene, Brixham, No. 48920 (Brit. Mus.).	*Meles taxus*, Pleistocene, Happaway (Brit. Mus.).	*Lutra vulgaris*, Prehistoric Burwell Fen, Camb. (Sedgwick Mus., Cambs.).
Radius.			
1. Length	3·0	9·1	6·4
2. Longer diameter at carpal articulations	·6	1·9	1·35

	Mustela robusta, Pleistocene, Ightham, nr. Maidstone (Lewis Abbott Coll.).	*Mustela putorius*, Pleistocene, Brixham, No. 48897 (Brit. Mus.).	*Mustela vulgaris*, Pleistocene, Ightham, nr. Maidstone (Corner Coll.).	*Meles taxus*, Pleistocene, Happaway, No. M. 5808 (Brit. Mus.).	*Lutra vulgaris*, Prehistoric, Burwell Fen (Sedgwick Mus.).
Ulna.					
Length	5·05	3·95	1·7	10·05	8·75

(4) Tables of Comparative Measurements of Bones of Posterior Limb.

	Mustela robusta, Pleistocene, Ightham, nr. Maidstone (Corner Coll.).	*Mustela putorius*, Pleistocene, Brixham, No. 48921 (Brit. Mus.).	*Mustela vulgaris*, var. *minuta*, Pleistocene, Ightham, nr. Maidstone (Corner Coll.)	*Meles taxus*, Pleistocene, Happaway, No. M. 5808 (Brit. Mus.).	*Lutra vulgaris*, Prehistoric, Burwell Fen (Sedgwick Mus.).
Femur.					
1. Length	6·4	4·7	2·05	12·3	9·45
2. Longer (right to left) diameter at condyles	1·3	1·0	·4	2·7	2·35

Table of Comparative Measurements—*continued.*

	Mustela robusta, Pleistocene, Ightham, nr. Maidstone (Corner Coll.).	*Mustela putorius*, Pleistocene, Brixham, No. 48922 (Brit. Mus.).	*Mustela vulgaris* Pleistocene, Ightham, nr. Maidstone (Lewis Abbott Coll.).	*Meles taxus*, Pleistocene, Happaway, No. M. 4933 (Brit. Mus.).	*Lutra vulgaris*, Prehistoric, Burwell Fen (Sedgwick Mus.).
Tibia.					
1. Length	6·7	4·75	1·85	10·95	10·4
2. Right to left diameter at proximal end	1·25	·95	·35	2·9	2·25

	Mustela robusta, Pleistocene, Ightham, nr. Maidstone (Lewis Abbott Coll.).	*Mustela putorius*, Pleistocene, Brixham (Brit. Mus.).	*Lutra vulgaris*, Prehistoric, Burwell Fen (Sedgwick Mus.).
Fibula.			
Length	5·2	4·65	9·4

IV. CONCLUSIONS.

The present memoir has afforded little scope for critical treatment and is almost purely descriptive in character. No novel conclusions have been reached. Of the eight species of Mustelidæ described, only the marten, glutton and badger appear in British Pliocene deposits, and only *Mustela robusta* and the glutton are no longer found in Britain. No Musteline remains are recorded from Scottish Pleistocene deposits, and only the marten, stoat, badger, and otter from those of Ireland.

Sincere thanks are tendered to Mr. W. J. Lewis Abbott, Dr. F. Corner, and the Rev. E. H. Mullins for kindly placing their large collections of Musteline bones from Ightham and Langwith at my disposal for examination and figuring. I am further indebted to Mr. H. St. George Gray, Mr. A. Newstead, Professor T. McKenny Hughes, Dr. R. F. Scharff and Dr. A. Smith Woodward for the loan of specimens preserved respectively in the Taunton Museum, Sedgwick Museum (Cambridge), Grosvenor Museum (Chester), the National Museum of Ireland and the British Museum. I further wish to thank Dr. C. W. Andrews, Mr. Oldfield Thomas and Mr. H. Woods for help and information, and Mr. J. Green for the care he has taken with the illustrations.

VI. BIBLIOGRAPHY.

1810. G. A. Goldfuss, 'Die Umgebungen von Muggendorf.'

1812. G. Cuvier, 'Recherches sur les Ossemens fossiles.'

1818. G. A. Goldfuss, "Beschreibung eines fossilen Vielfrass-Schädels aus den Gailenreuther Höhle," 'Nova Acta Acad. Caes. Leop.,' ix, p. 313.

1822—23. J. F. Krueger, 'Geschichte der Urwelt,' p. 851. . . . Quedlinburg and Leipzig.

1823. G. A. Goldfuss, 'Säugethiere der Vorwelt.'

1823. G. Cuvier, 'Recherches sur les Ossemens fossiles,' ed. 2, iv.

1824. W. Buckland, 'Reliquiæ Diluvianæ,' p. 15.

1825. G. Cuvier, 'Recherches sur les Ossemens fossiles,' ed. 3, iv.

1828. J. B. Croizet and A. C. G. Jobert, 'Recherches sur les Ossemens fossiles du Département du Puy-de-Dôme,' p. 89.

1829—31. F. Holl, 'Handbuch der Petrefactenkunde.'

1832. H. von Meyer, 'Palæologica,' p. 47.

1833. P. C. Schmerling, 'Recherches sur les Ossemens fossiles—Cavernes de Liège.'

1834. G. Cuvier, 'Recherches sur les Ossemens fossiles,' ed. 4, vii, pp. 484—516.

1836. G. von Münster, 'Verzeichniss der Versteinerungen . . . zu Baireuth,' p. 87.

1839. J. C. Bellamy, 'Natural History of South Devon,' pp. 86—101.

1839. M. de Serres, J. M. Dubrueil, and B. Jeanjean, 'Recherches sur les Ossemens humatiles des Cavernes de Lunel Viel,' p. 67.

1842. R. Owen, "Report on the British Fossil Mammalia," 'Rep. Brit. Assoc.,' Manchester, pp. 70—72.

1844. H. M. D. de Blainville, 'Ostéographie,' fasc. 4.

1846. R. Owen, 'A History of British Fossil Mammals and Birds,' pp. 109—122.

1847. C. G. Giebel, 'Fauna der Vorwelt,' i, pp. 55—64.

1847. A. Nordmann, 'Découverte de Gîtes riches en Ossemens fossiles faite en 1846 à Odessa.'

1853. F. J. Pictet, 'Traité de Paléontologie,' i, pp. 214—220.

1859. P. Gervais, 'Zoologie et Paléontologie Françaises,' pp. 243—253.

1859. H. von Meyer, "*Meles vulgaris* aus dem diluvialen Charen-Kalke bei Weimar," 'Palæontographica,' vii, pp. 41—45.

1866. W. Boyd Dawkins and W. A. Sanford, "British Pleistocene Mammalia," 'Pal. Soc.,' i, pp. xxi, xxii.

1868. H. Wankel, "Die Slouper Höhle und ihre Vorzeit," 'Denkschr. k. Akad. Wiss. Wien.,' xxviii, pt. 2, p. 95.

1869. W. Boyd Dawkins, "On the Distribution of the British Post-glacial Mammals," 'Quart. Journ. Geol. Soc.,' xxv, p. 192.

1870. E. Cornalia, "Monographie des Mammiféres fossiles de Lombardie," 'Pal. Lomb.,' ed. Stoppani, ser. 2, pp. 20—31, pl. xi.

1871. W. Boyd Dawkins, "On the Discovery of the Glutton in Britain," 'Quart. Journ. Geol. Soc.,' xxvii, p. 406.

1871. W. Pengelly, 'Trans. Devon Assoc.,' iv, pp. 98, 102.

1875. G. Busk, "List of the Mammalian Remains . . . in the Rock Fissure Cavern in Creswell Crags, Derbyshire," 'Quart. Journ. Geol. Soc.,' xxxi, p. 683.

1878. A. Nehring, "Die quaternären Faunen von Thiede und Westregeln nebst Spuren des vorgeschichtlicher Menschen," 'Archiv für Anthropologie,' x, p. 378.

1879. E. R. Alston, "On the Specific Identity of the British Martens," 'Proc. Zool. Soc.,' pp. 468—474; and 'Zoologist,' iii, pp. 441—448.

1879. T. Liebe, "Die fossile Fauna der Höhle Vypustek in Mähren," 'Sitzb. k. Akad. Wiss. Wien.,' lxxix, pt. i, p. 472.

1880, 1882, and 1884. A. Woldrich, "Diluviale Fauna von Zuzlawitz bei Winterberg im Böhmerwald," ibid., lxxxii (1880), p. 32; lxxxiv (1882), p. 194; and lxxxviii (1884), p. 993.

1881. A. L. Adams, "Report on the Animal Remains of the Bone Cave of Ballynamintra, co. Waterford," 'Trans. Roy. Dublin Soc.,' (2) i, p. 208.

1881. R. F. Hensel, "Craniologische Studien," 'Nova Acta Acad. Caes. Leop.,' xlii, p. 125.

1882. E. T. Newton, "Vertebrata of the Forest Bed Series of Norfolk," 'Mem. Geol. Surv.,' p. 25.

1885. R. Lydekker, 'Catalogue of the Fossil Mammalia in the British Museum,' i, pp. 176—191.

1885. E. Wilson, "The Bone Cave or Fissure of Durdham Down," 'Proc. Bristol Nat. Soc.,' N.S., v, p. 44.

1886. H. Hicks, "On the Ffynnon Beuno and Cae Gwyn Caves," 'Geol. Mag.,' (3) iii, p. 566.

1886. F. Winterfeld, 'Ueber quartäre Mustelidenreste Deutschlands.' Berlin.

1890. E. T. Newton, "On some New Mammals from the Red and Norwich Crags," 'Quart. Journ. Geol. Soc.,' xlvi, p. 444.

1890. A. Smith Woodward and C. Davies Sherborn, 'A Catalogue of British Fossil Vertebrata.' London.

1891. E. T. Newton, "Vertebrata of the Pliocene Deposits of Britain," 'Mem. Geol. Surv.,' p. 10.

1894. E. T. Newton, "The Vertebrate Fauna of the Ightham Fissure," 'Quart. Journ. Geol. Soc.,' l, p. 200.

1899. M. Boule and G. Chauvet, "Sur l'Existence d'une Faune d'Animaux arctiques dans la Charente á l'Epoque quaternaire," 'Comptes Rendus,' cxxviii, p. 1188.

1899. E. T. Newton, "Additional Notes on the Vertebrate Fauna of the Rock Fissure at Ightham (Kent)," 'Quart. Journ. Geol. Soc.,' lv, p. 425.

1900. E. Wilson and S. H. Reynolds, "Uphill Bone Caves," 'Proc. Bristol Nat. Soc.,' N.S., ix, p. 152.

1903. R. F. Scharff, "Exploration of the Caves of Kesh, co. Sligo (Mammals except Man)," 'Trans. Roy. Irish Acad.,' xxxii, B, pt. 4, p. 202—205.

1906. E. F. Hamy, "Le *Gulo borealis* dans la Grotte de la Grande Chambre à Rinxent, Pas de Calais," 'Bull. Mus. Hist. nat. Paris,' xii, p. 137.

1906. R. F. Scharff, "Exploration of the Caves of co. Clare (Animal remains except Birds)," 'Trans. Roy. Irish Acad.,' xxxiii, B, pt. i, p. 205.

1910. J. W. Jackson, "On the Vertebrate Fauna found in the Cave-earth at Dog Holes, Warton Crag," 'Lancashire Naturalist,' Feb., 1910, p. 330.

PLATE I.

Pleistocene Mustelidæ.

Cranium and Mandible.

Polecat (*Mustela putorius*), and Giant Polecat (*Mustela robusta*).

(Natural size.)

Mustela putorius.

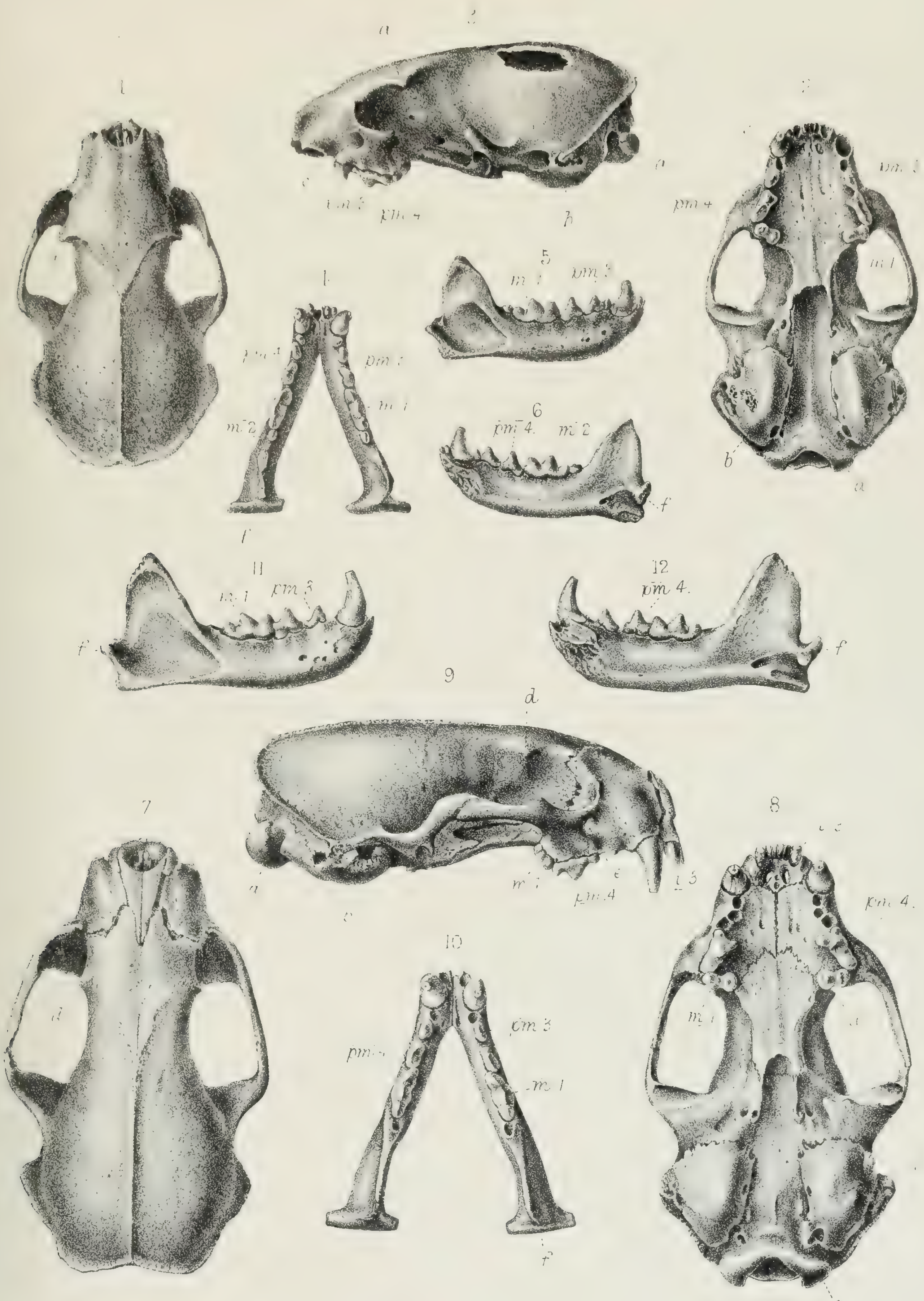
Fig.

1. Dorsal } view of a ? Prehistoric cranium from Ightham, near Maidstone
2. Ventral } (Corner Coll.).
3. Lateral view of a cranium from Brixham (Brit. Mus.).
4. Palatal view of the corresponding mandible (Brit. Mus.).
5. Outer } aspect of the same mandible.
6. Inner }

Mustela robusta.

7. Dorsal } view of a cranium from Ightham, near Maidstone (Lewis Abbott
8. Ventral } Coll.).
9. Lateral }
10. Palatal view of the corresponding mandible (Lewis Abbott Coll.).
11. Outer } aspect of the same mandible.
12. Inner }

a. Occipital condyle } Plates I to VI.
b. Auditory bulla
d. Post-orbital process of frontal
e. Infra-orbital foramen
f. Mandibular condyle



J. Green del. lith. et imp.

POLECAT: MUSTELA PUTORIUS, & GIANT POLECAT: M. ROBUSTA.
Cranium & mandible.

PLATE II.

Pleistocene Mustelidæ.

Cranium and Mandible.

Marten (*Mustela martes*), Stoat (*Mustela erminea*), and Weasel (*Mustela vulgaris*).

(All except fig. 12 *a* natural size.)

Mustela martes.

Fig.

1. Dorsal, 2. Ventral, 3. Lateral view of a ? Prehistoric cranium from the Edenvale Cave, co. Clare (National Mus., Dublin).

4. Inner, 5. Outer view of a left mandibular ramus from the Pleistocene of the Langwith Cave, near Mansfield (Mullins Coll.).

Mustela erminea.

6. Dorsal, 7. Lateral view of a cranium from the Pleistocene of Berry Head (Brit. Mus.).

8. Outer aspect of the right ramus of the corresponding mandible (Brit. Mus.).

9. Ventral view of an imperfect cranium from the Pleistocene of Kent's Hole, Torquay (Brit. Mus.).

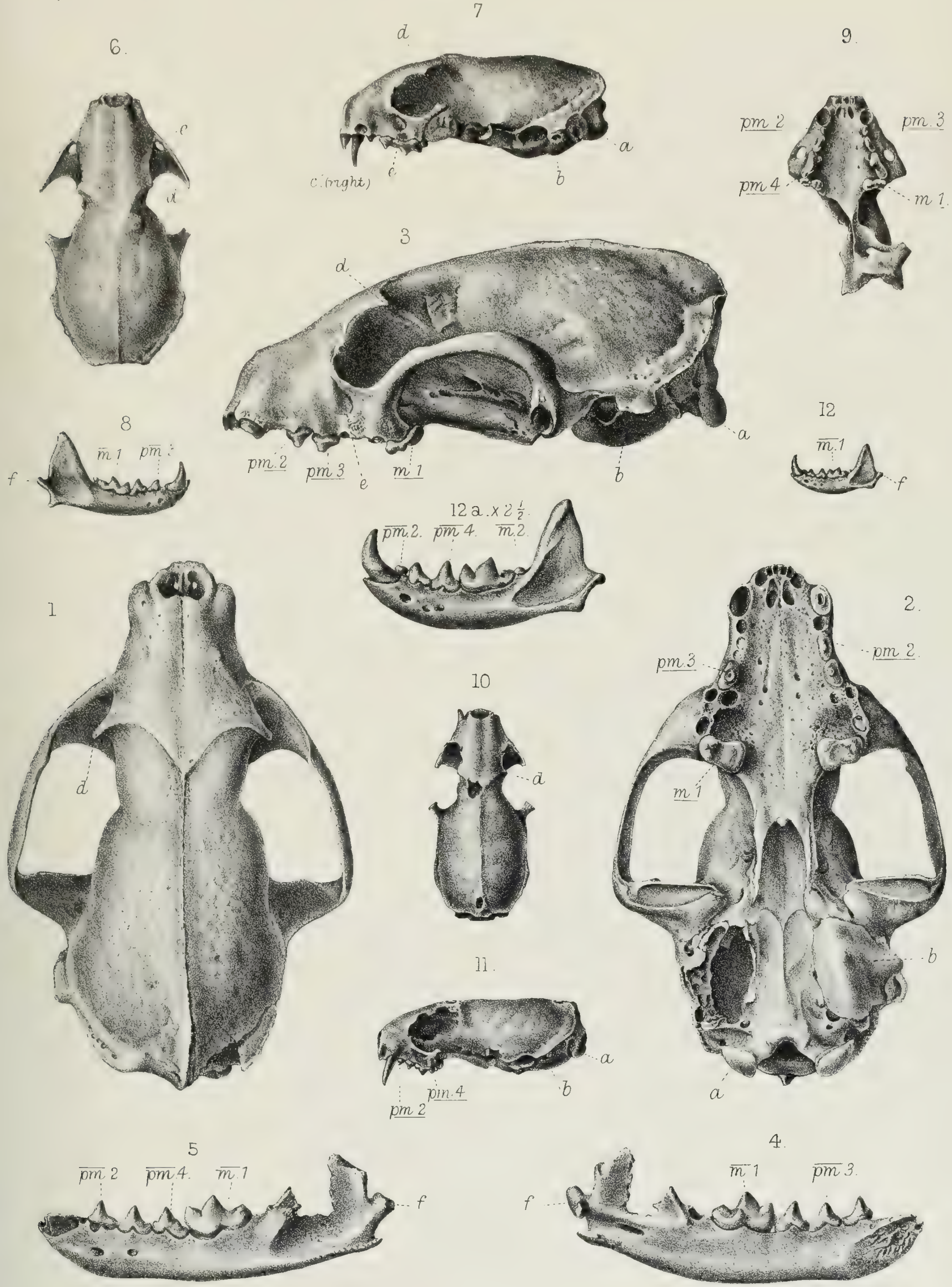
Mustela vulgaris.

10. Dorsal, 11. Lateral view of a cranium from the Pleistocene of the Ightham Fissure, near Maidstone (Lewis Abbott Coll.).

12. Left mandibular ramus seen from the outer side, from the Pleistocene of the Brixham Cave (Brit. Mus.).

12 *a*. The same two and a half times natural size.

Lettering as in Plate I.



J.Green del. lith. et imp.

MARTEN: MUSTELA MARTES, STOAT: M.ERMINEA, & WEASEL: M.VULGARIS.
Cranium & mandible.

PLATE III.

PLEISTOCENE MUSTELIDÆ.

Cranium and Mandible.

Weasel (*Mustela vulgaris*, var. *minuta*), and Badger (*Meles taxus*).

(Natural size except figs. 2 *a* and 4 *a*.)

Mustela vulgaris (var. *minuta*).

FIG.

1. Dorsal
2. Ventral } view of a cranium from the Pleistocene of Ightham, near Maidstone (Corner Coll.).
3. Lateral

2 *a*. Anterior part of fig. 2 two and a half times natural size.

4. Associated right mandibular ramus seen from the inner side (Corner Coll.).

4 *a*. The same nearly three times natural size.

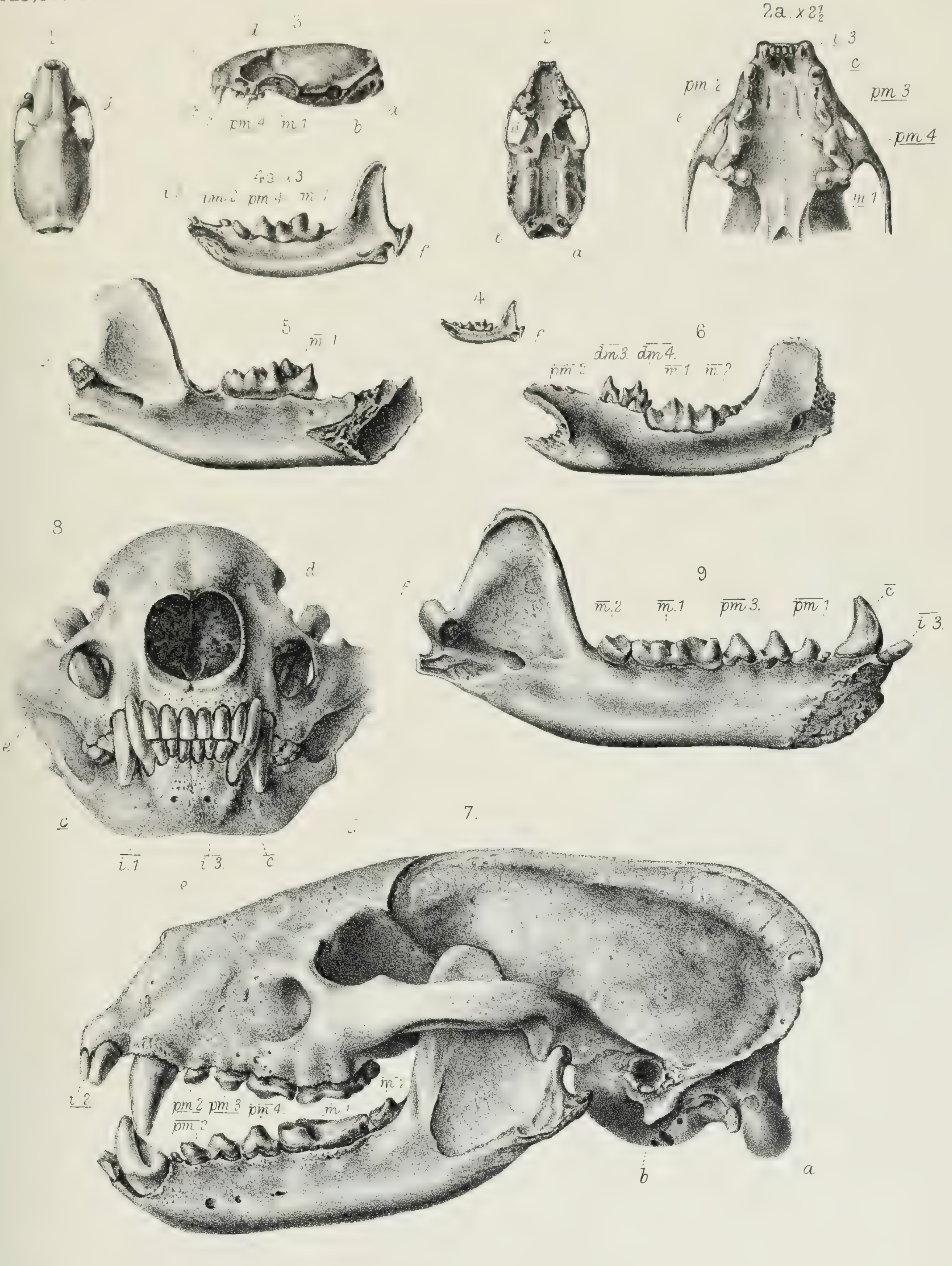
Meles taxus.

5. Left mandibular ramus of a young individual seen from the inner side.
6. Left mandibular ramus of a young individual seen from the outer side.

   Both the above specimens are from the Pleistocene of the Happaway Cave; 5 is preserved in Dr. F. Corner's Collection; 6 in the British Museum.

7. Left side view } of a cranium and mandible from the Langwith Cave, Mansfield (Mullins Coll.).
8. Anterior view
9. Inner view of a left mandibular ramus from the same locality (Corner Coll.).

Lettering as in Plate I.



J.Green del. lith. et imp.

WEASEL: MUSTELA VULGARIS (VAR. MINUTA), & BADGER: MELES TAXUS.

Cranium & mandible.

PLATE IV.

PLEISTOCENE MUSTELIDÆ.

Cranium.

Badger (*Meles taxus*).

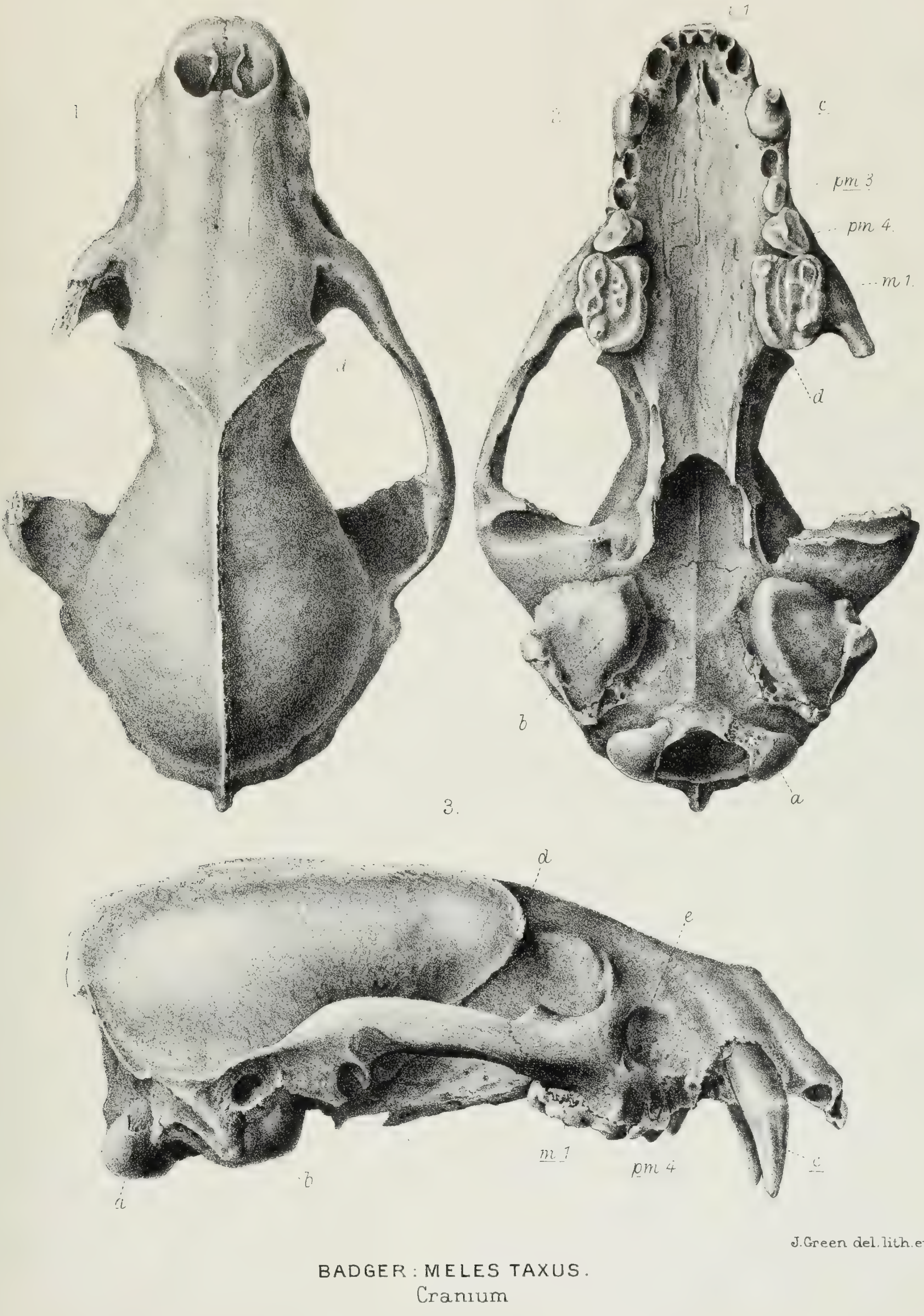
(Natural size.)

FIG.

1. Dorsal
2. Ventral
3. Lateral

} view of a cranium from the Pleistocene of Grovehurst, Sittingbourne (Brit. Mus.).

Lettering as in Plate I.



J. Green del. lith. et imp.

BADGER: MELES TAXUS.

Cranium

PLATE V.

PLEISTOCENE MUSTELIDÆ.

Cranium.

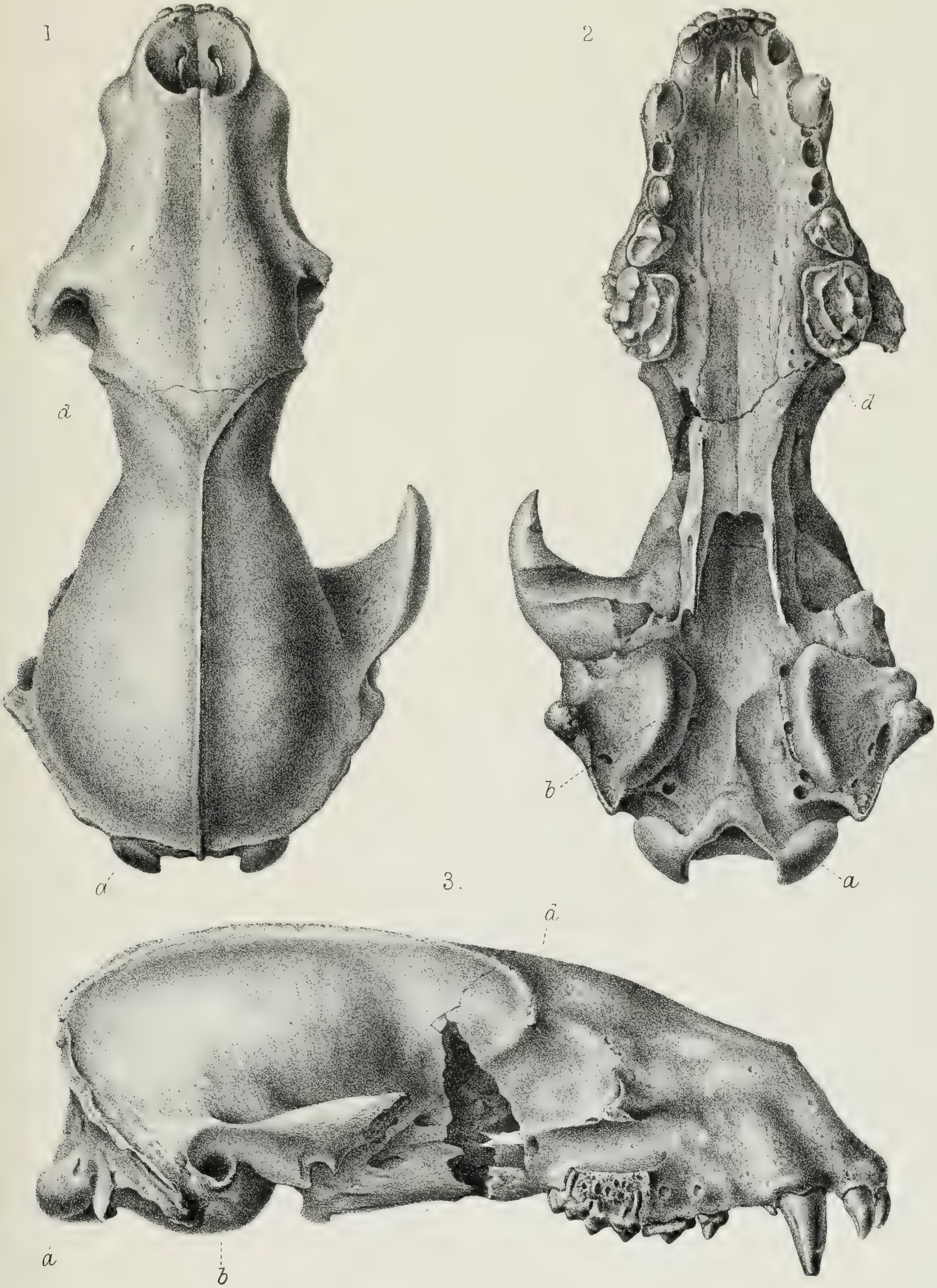
Badger (*Meles taxus*), var.

(Natural size.)

FIG.

1. Dorsal, 2. Ventral, 3. Lateral view of a remarkably elongated cranium from the Pleistocene of the Langwith Cave, near Mansfield (Corner Coll.).

Lettering as in Plate I.



J. Green del. lith. et imp.

BADGER: MELES TAXUS. (VAR.)
Cranium.

PLATE VI.

PLEISTOCENE MUSTELIDÆ.

Cranium and Mandible.

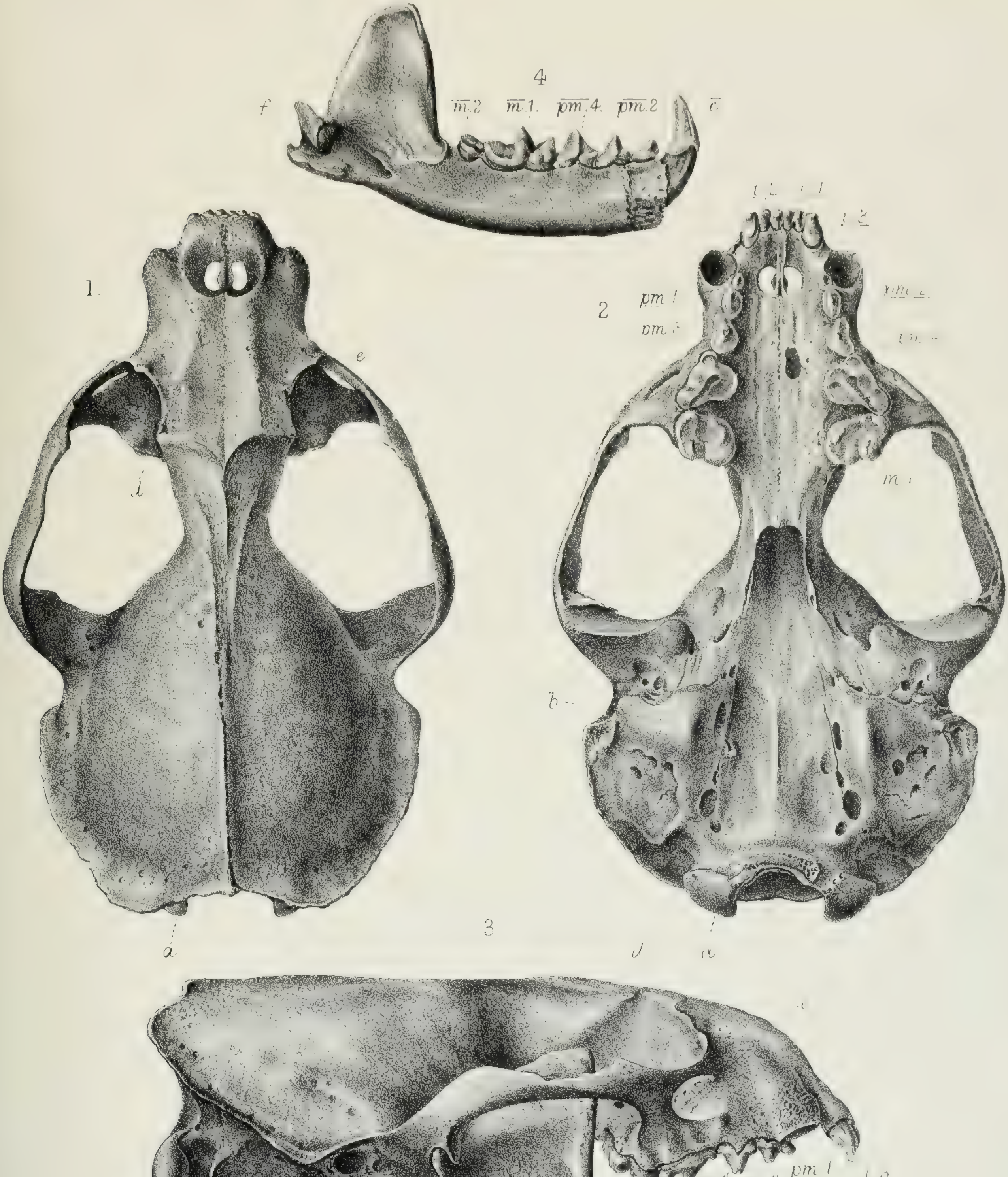
Otter (*Lutra vulgaris*).

(Natural size.)

FIG.

1. Dorsal } view of a cranium from the Prehistoric peat of Burwell Fen
2. Ventral } (Sedgwick Mus., Cambridge).
3. The same cranium with the associated mandible seen from the right side.
4. Inner view of the left ramus of the above mandible.

Lettering as in Plate I.



J.Green del.lith.et imp.

OTTER: LUTRA VULGARIS.
Cranium & mandible

PLATE VII.

Pleistocene Mustelidæ.

Vertebræ.

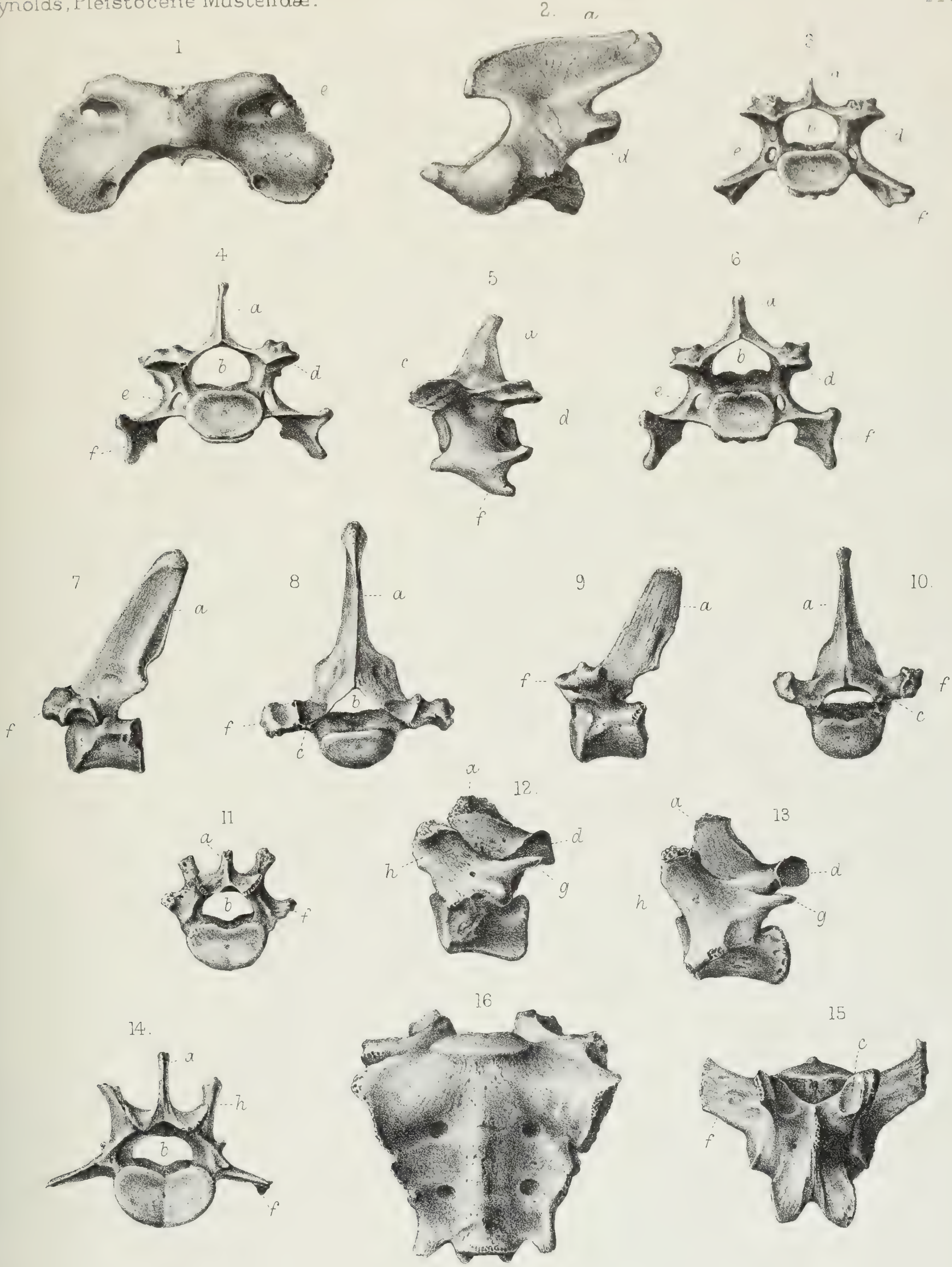
Badger (*Meles taxus*).

(Natural size.)

Fig.		
1.	Atlas, dorsal view	From the British Museum Collection.
2.	Axis, left side view	
3.	Third cervical, posterior view	
4.	Fourth cervical, posterior view	From the collection of Dr. F. Corner, F.G.S., of Poplar.
5.	The same bone, left side view	
6.	Fifth cervical, posterior view	
7.	First thoracic, left side view	From the British Museum Collection.
8.	Dorso-anterior view of the same bone	
9.	Fifth thoracic, left side view	
10.	Dorso-anterior view of the same bone	
11.	Thirteenth thoracic, posterior view	From the collection of Dr. F. Corner, F.G.S.
12.	Fifteenth thoracic, left side view	
13.	First lumbar, left side view	From the British Museum Collection.
14.	Third lumbar, posterior view	
15.	The same bone seen from above	
16.	Sacrum, ventral view	

All these vertebræ are from the Pleistocene of the Happaway Cave, Devon.

a.	Neural spine	Plates VII and VIII.
b.	Neural canal	
c.	Pre-zygapophysis	
d.	Post-zygapophysis	
e.	Vertebrarterial canal	
f.	Transverse process	
g.	Anapophysis	
h.	Metapophysis	



J. Green del. lith. et imp.

BADGER: MELES TAXUS.

Vertebræ.

PLATE VIII.

Pleistocene Mustelidæ.

Vertebræ.

Polecat (*Mustela putorius*), and Otter (*Lutra vulgaris*).

(Natural size.)

Mustela putorius.

Fig.

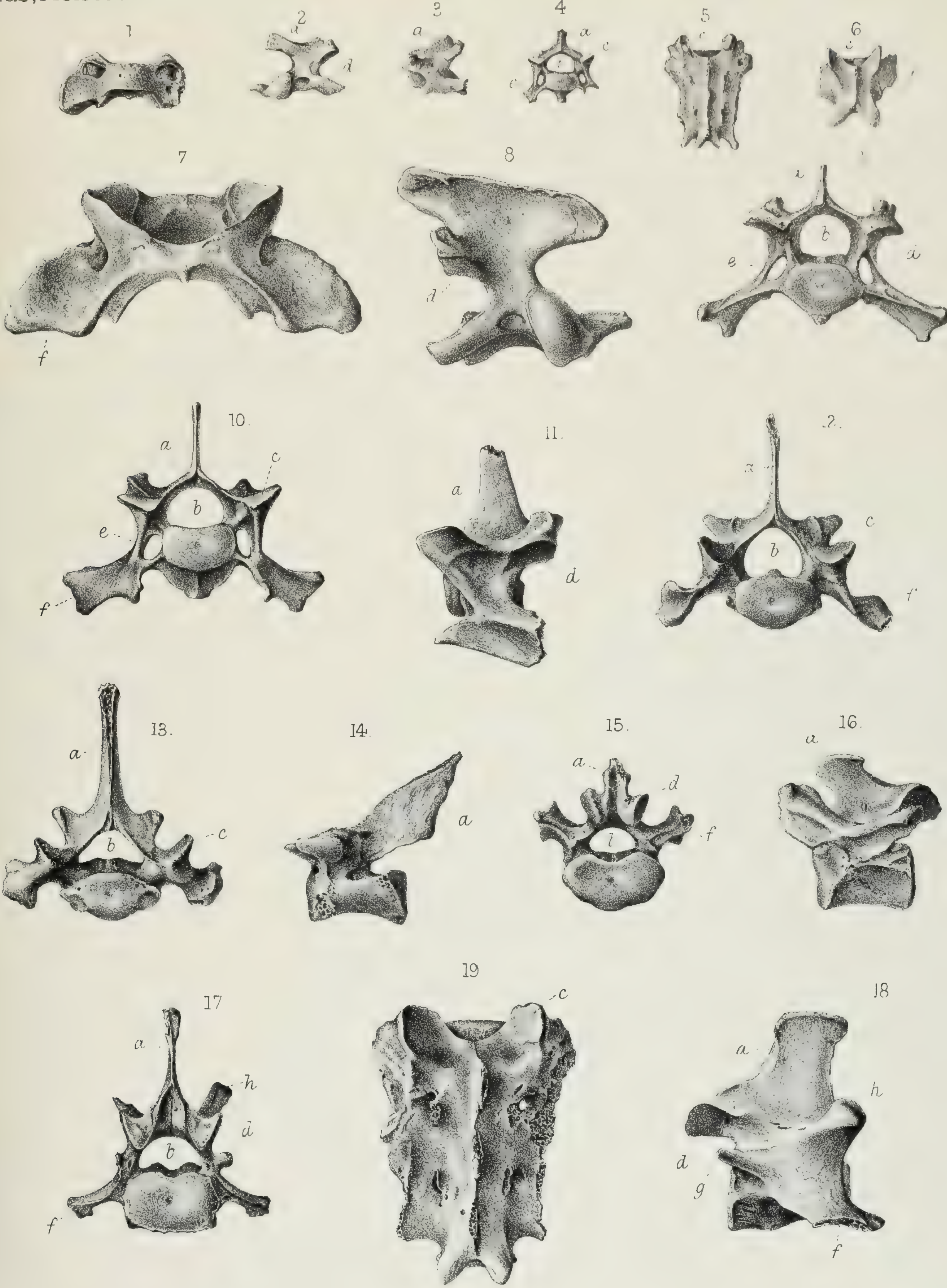
1.	Atlas, dorsal view	All from the Pleistocene of the Brixham Cave, and preserved in the British Museum.
2.	Axis, left side view	
3.	Fourth cervical, left side view	
4.	The same bone, anterior view	
5.	Sacrum, dorsal view	
6.	Sixth lumbar, dorsal view	

Lutra vulgaris.

7. Atlas, ventral view.
8. Axis, seen from the right side.
9. Third cervical, posterior view.
10. Fifth cervical, anterior view.
11. Sixth cervical, seen from the left side.
12. Seventh cervical, anterior view.
13. First thoracic, anterior view.
14. Ninth thoracic, seen from the left side.
15. Twelfth thoracic, posterior view.
16. Thirteenth thoracic, seen from the left side.
17. Fourth lumbar, posterior view.
18. Fourth lumbar, seen from the right side.
19. Sacrum, dorsal view.

All the Otter vertebræ figured are from the Prehistoric peat of Burwell Fen, and are preserved in the Sedgwick Museum, Cambridge.

Lettering as in Plate VII.



J. Green del. lith. et imp.

POLECAT: MUSTELA PUTORIUS, & OTTER: LUTRA VULGARIS.

Vertebræ.

Palæontographical Society, 1911.

THE

GANOID FISHES

OF THE

BRITISH CARBONIFEROUS FORMATIONS.

BY

RAMSAY H. TRAQUAIR, M.D., LL.D., F.R.S.,

LATE KEEPER OF THE NATURAL HISTORY COLLECTIONS IN THE ROYAL SCOTTISH MUSEUM, EDINBURGH.

PART I, No. 6.

PALÆONISCIDÆ.

PAGES 159—180; PLATES XXXVI—XL.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

FEBRUARY, 1912.

PRINTED BY ADLARD AND SON, LONDON AND DORKING.

maxilla is of the usual Palæoniscoid shape and has its broad postorbital portion covered with wavy and contorted ridges, which in most instances pass into a narrow band of irregularly-shaped tubercles stretching along the dentary margin. The mandible is very stout, its depth behind equalling two-sevenths of its length ; in shape it rapidly tapers towards the symphysis. Externally it is covered with closely set, slightly wavy ridges, which, running from behind forwards, diverge from each other along a longitudinal line placed rather below the middle of the bone, on whose upper and lower margin they obliquely impinge, but the striæ forming the lower side of this somewhat feather-like pattern are much more horizontal in direction than those on the upper side. The jaws are armed with conical teeth of two sizes, large ones being placed at short intervals inside a row of minute external ones.

The bones of the shoulder-girdle are striated with tolerably coarse wavy ridges, which, on the upper or vertical part of the clavicle, are again fretted with minute transverse indentations.

The scales of the body are of moderate size, rhomboidal and tolerably thick. On the front part of the flank (figs. 6, 7) they are tolerably equilateral, with slightly concave upper and convex lower margin ; the covered area is very narrow ; the articular peg moderate in size, and the keel of the attached surface only slightly developed. Towards the tail (fig. 9) and along the back the scales become smaller and more oblique, and in front of the dorsal fin there are four or five imbricating median scales of a larger size. Along the belly (fig. 8) they become very low and narrow, and on the caudal body-prolongation they are, as usual, small, and acutely lozenge-shaped, while imbricating V-scales clothe the upper margin of this part. The scales are marked externally by a very ornate and easily recognised sculpture, though it is excessively difficult by means of words to give anything like an adequate idea of its peculiarities. It consists of sharp furrows or grooves, sometimes interrupted and intercalated, some of which run parallel with the anterior and inferior margins, while others run more or less diagonally across the remaining portion of the sculptured area. According to the elevation or flatness of the interspaces between these furrows, a greater or less appearance of ridging is produced in different specimens (compare figs. 6 and 7), and in all the ridged appearance is pretty strongly developed in the scales of the back between the dorsal fin and the occiput. The ornament becomes less sharp posteriorly, but nevertheless it is developed to a greater or less extent even on the scales of the caudal body-prolongation. Some amount of a tolerably coarse denticulation is also observable, especially on the flank-scales, and, as very commonly happens, it disappears towards the margins of the body and the tail.

As regards the pectoral fin, I stated in my first notice of this species that so far as can be made out by careful examination with a good lens its principal rays seem to be articulated up to very near their origins—a feature which would certainly be at variance with the characters of *Rhadinichthys*, and hence I appended a "?" to its position in

that genus. Re-examination of the case, however, makes me doubtful if my former interpretation of it be correct. The specimen is distorted and fragmentary, and though the fin in question is near the head, its connection with the shoulder-girdle is not seen, and it has accordingly struck me that we have here to do, not with the pectoral, but with the ventral fin. At all events, in the specimen represented in Pl. XXXV, fig. 5, we have distinct remains of the pectoral fin in the form of several rays which are still unarticulated, though of considerable length. I may say, however, that in no specimen which I have as yet seen, is there a satisfactory demonstration of the structure of the pectoral fin.

The ventral fin is also seldom well seen; an exception to this rule is, however, met with in the specimen represented in fig. 4, in which a well-developed ventral is seen, with rays which are moderately closely articulated. The dorsal is placed far back, its anterior commencement being only very slightly in front of that of the nearly opposed anal. Both fins are of good size and expanse, triangular-acuminate, their rays delicate with rather distant articulations, the joints being smooth or with one longitudinal furrow. The caudal is powerful, deeply cleft, and inequilobate, the upper lobe being nearly twice as long as the lower; its rays are delicate, smooth, dichotomising towards their extremities, and divided by tolerably distant transverse articulations. The anterior margins of all the fins are minutely fulcrated.

Observations.—The characteristic features of the above-described interesting Palæoniscid are so distinct and striking that we are fortunately free from any troublesome doubts and questions as to species, for even although the scale-markings may show some amount of individual variation as to their strength and sharpness, it is easy to pick out even fragmentary remains of *fusiformis* and place them together as belonging to one well-defined form. And after what I have said above regarding the pectoral fin, I consider myself justified in removing the query with which I formerly qualified its position in the genus *Rhadinichthys*.

Geological Position and Locality.—Common in the fish-beds of Calciferous Sandstone age near Glencartholm, Eskdale.

18. Rhadinichthys (?) angustulus, *Traquair*. Plate XXXVI, figs. 1, 2.

Rhadinichthys (?) angustulus, *Traquair*. Trans. Roy. Soc. Edinb., vol. xxx, 1881, p. 33, pl. ii, figs. 10, 11.
— — *A. S. Woodward*. Cat. Foss. Fishes Brit. Mus., pt. ii, 1891, p. 468.

Specific Characters.—A fish of very small size; head proportionately large; tail-pedicle deep; scale-sculpture consisting of a few delicate, straight, non-bifurcating transverse ridges.

Description.—The following description is taken from two specimens in the collection of the Geological Survey of Scotland, one of which, the larger and less perfect, measures $2\frac{1}{4}$ inches in length, while the other and more perfect example (Pl. XXXVI, fig. 1) attains a length of only $1\frac{1}{2}$ inches. The length of the head is equal to about one-quarter of the total; the greatest depth of the body is at the shoulder, and is contained about six times in the entire length of the fish, while it is not so much as twice the depth of the tail-pedicle, the dorsal and ventral margins being nearly straight. The general contour is therefore peculiarly short and straight, and wanting in the usual more or less fusiform outline, while the tail-pedicle is of great proportional depth.

All that can be said of the head is that it is typically Palæoniscoid in structure, with oblique suspensorium, etc., and that some traces of a minute ridged ornament are seen on some of its delicate bones, *e.g.* the mandible. The body-scales (fig. 2) are of moderate dimensions in proportion to the size of the fish, and are marked each with three or four delicate, yet sharply defined, and somewhat distant ridges, which run right across the outer surface of the scale from before backwards, parallel with the superior and inferior margins; on the minute lozenge-shaped scales of the caudal body-prolongation these ridges, now excessively fine, are diagonal in position. The V-scales of the tail are proportionally largely developed.

The pectoral and ventral fins are small, the dorsal and anal nearly opposite, though the former arises a little in advance of the latter. The two last-named fins resemble each other in their triangular-acuminate contour; the caudal is not completely preserved, but its appearance seems to indicate that it was bifurcated in the usual manner. The fins are preserved only in the smaller of the two specimens, and their rays are so excessively delicate that it is impossible to describe their articulations, but they are closely set, and appear to bifurcate towards their extremities.

Observations.—On account of its general structure, so far as can be made out, along with the form and position of the fins, though the condition of the rays of the pectoral cannot be established, this strange little fish may be placed, at least provisionally, in the genus *Rhadinichthys.* As regards the scales, a somewhat similar sculpture may be seen on those of various other Carboniferous Palæoniscidæ, such as *Elonichthys microlepidotus* and *E. striatulus, Rhadinichthys Grossarti* and *Styracopterus fulcratus*, but the present species is distinguished from all these by obvious details of form. It seems to be somewhat rare; two specimens are in the collection of the Geological Survey of Scotland, while another is noted by Dr. A. Smith Woodward as belonging to the British Museum.

Geological Position and Locality.—Only known as yet from the fish-bearing shales of Calciferous Sandstone age exposed in the banks of the River Esk near Glencartholm.

Genus—Myriolepis, *Egerton*, 1864.

Generic Characters.—Fusiform; suspensorium oblique; gape wide; teeth conical; dorsal fin placed nearly opposite the interval between the ventrals and the anal; caudal completely heterocercal, inequilobate; scales minute, rhombic and striated; fulcra, when visible, very minute.

This genus was founded by Sir Philip Grey Egerton[1] on two specimens from the Keuper of New South Wales—one without fins, while the other was represented by a photograph, showing the head of the fish with the pectoral, ventral, and dorsal fins, the anal and caudal being wanting. The affinities of the fish, which was, moreover, remarkable for the minuteness of its scales, were supposed to be with *Acrolepis,* which according to modern ideas implied that they were Palæoniscid.

Twenty-six years afterwards[2] Dr. A. Smith Woodward published descriptions and figures of the same species from the same locality and horizon, as well as of a second species (*M. latus*), which clearly showed that, except in the smallness of the scales, the genus was typically Palæoniscid, with the fins shaped and placed much as in *Elonichthys* and *Acrolepis.* The condition of the rays of the pectoral fin, as regards transverse articulation, remains, however, still doubtful in the type species of the genus.

In 1893 I published a description of a new Palæoniscid fish from the Coal Measures of Co. Kilkenny, Ireland, contained in the Museum of the Owens College, Manchester, which I referred to this genus under the name of *Myriolepis Hibernicus* on account of the smallness of the scales and other resemblances which it bore to the Australian *M. Clarkei,* and with it I also identified another specimen from the same locality in the Geological Museum in Jermyn Street, London. In both of these specimens the tail is wanting, but that deficiency in the Carboniferous species has now been remedied by specimens figured by H. Bolton and by Smith Woodward, to which reference will be made in their proper places.

1. Myriolepis Hibernica, *Traquair.* Plate XXXVI, fig. 3; Plate XXXVII, figs. 1—3.

Myriolepis hibernicus, *Traquair.* Geol. Mag. [3], vol. x, 1893, pp. 51—56, pl. iii.
— — *Herbert Bolton.* Trans. Geol. Soc. Manchester, vol. xxii, 1894, pp. 1—4, pls. i, ii.
— — *A. S. Woodward.* Ann. and Mag. Nat. Hist. [7], vol. xviii, pp. 416—419, pl. x.

[1] "On Some Ichthyolites from New South Wales," in 'Quart. Journ. Geol. Soc.,' vol. xx, 1864, pp. 1—5, pl. i.

[2] "Fossil Fishes of the Hawkesbury Series at Gosford, N. S. Wales," 'Mem. Geol. Surv. N.S. Wales,' No. 4 (Sydney, 1890), pp. 7—11, pl. ii, figs. 3, 4, pl. iii, figs. 1—3.

Description.—In Plate XXXVI, fig. 3, is represented the specimen in the Jermyn Street Museum, in which we have a good general indication of the contour of the fish, though it is deficient in the caudal region, being cut off just behind the dorsal and anal fins. The head is a little twisted upwards on the shoulder; making allowance for that and for the lost tail-end, the original length may be estimated at about thirteen inches, of which three may be allotted to the head, the length of which will therefore be contained a little over four times in the total.

In the head the cranial roof-bones appear to have been finely tuberculated. The suspensorium is very oblique, impressions of the operculum and branchiostegal plates are feebly visible, and in the mouth are indications of the presence of conical teeth.

So far as the internal skeleton is visible it conforms to the Palæoniscoid type, but it is not well shown.

The pectoral fin is of moderate size for the fish; in its contour it is rounded distally; its first ray seems to be unarticulated, but the rest are jointed up to their origins. The ventral fin is rather long-based and is placed right between the pectoral and the anal.

The dorsal and anal, also moderate in size, are triangular-acuminate in contour; the dorsal is situated partly opposite the anal and partly opposite the space between that fin and the ventral. The rays of all these fins are numerous, fine and closely articulated, but I have not detected any fulcra. Nor are the markings on the fin-rays here observable.

The scales are very small, being about $\frac{1}{10}$ inch across; as regards their markings, these are like those of the fin-rays, namely, invisible in this specimen.

So far we have a fish whose configuration reminds us of *Elonichthys*, except that perhaps the dorsal fin looks a little further back than is usually the case in that genus; now, to complete the figure, we want the tail and the caudal fin. This part is supplied in another specimen described and figured by Mr. Herbert Bolton in 1894, and Mr. Bolton's remarks, not being lengthy, may be quoted in full: "The additional information of *Myriolepis Hibernica* supplied by this specimen may be summarised by saying that the species possessed a powerful heterocercal tail of the Palæoniscid type, and that the head-bones were thin and covered by a ganoine layer of fine raised ridges. The opercular apparatus was continued underneath the jaw by a numerous series of branchiostegal rays."

Dr. Smith Woodward has, however, described and figured a remarkable specimen, which not only shows all the fins, but raises some interesting points regarding the specific characters of the fish itself, and to the kindness and complaisance of its describer I enjoy the privilege of refiguring the specimen and of making some comments thereon.

The specimen (Brit. Mus., P. 9604), Pl. XXXVII, fig. 1, is comparatively small, its length being equal to about $6\frac{1}{2}$ inches as it lies, wanting a good piece of the upper lobe

of the caudal fin. It yields us in the first place a view of the external markings of the scales and of the fin-rays. The scales resemble those of the Jermyn Street specimen in size and in form, the ornament which is seen on their outer surfaces (fig. 2) consisting of fine flexuous ridges passing into tubercles and mainly horizontal in direction. The pectoral fin has, as in the other specimen, a broad rounded contour, but its termination extends as far as to opposite the commencement of the ventral, the contour of which is well preserved and shows some minute fulcra along the anterior margin; the dorsal fin commences opposite the origin of the ventrals; the anal fin is of the usual triangular acuminate form; the tail-pedicle seems unusually deep for the size of the fish; the sculpture of the joints of the fin-rays consists of fine longitudinal striations (fig. 3).

The British Museum specimen, as it lies on the stone before us, differs obviously from the Jermyn Street one in the following particulars:

(1) The fins on the ventral aspect of the body and the intervals between them are smaller. For example the pectoral fin, as has been already remarked, has its apex reaching to opposite the commencement of the ventral.

(2) The dorsal fin is situated further forwards, the front of it being opposite the beginning of the ventral.

(3) The caudal pedicle is proportionately deeper than in the Jermyn Street specimen, at least it is so calculating from the contour of the hinder extremity of the body in that specimen.

Now, of these discrepancies, only two explanations are possible—either we are dealing with a distinct species, or the British Museum specimen has been, as is so common with the Palæozoic "Ganoids," subjected to deformation by irregular pressure during the process of fossilisation. The latter explanation seems to me to be the more readily acceptable, and Dr. Smith Woodward has already in his description of the specimen in question noticed "the crushing of the head a little downwards and backwards upon the anterior part of the abdominal region." I would refer the apparent anterior position of the dorsal fin and the appearance of the tail-pedicle to the same cause.

Geological Position and Locality.—From the Coal Measures (Upper Carboniferous) of Co. Kilkenny, Ireland.

Genus—Phanerosteon, *Traquair*, 1881.

Generic Characters.—Fusiform; completely heterocercal; dorsal fin acuminate, but not, strictly speaking, triangular; anal fin commencing opposite the middle of the dorsal; caudal inequilobate, bifurcated; rays of all the fins delicate, bifurcating once; fulcra absent; principal rays of pectoral articulated. Head typically Palæoniscoid in structure, with oblique suspensorium, and anteriorly-placed orbit; maxillary and mandibular teeth conical, sharp, enamel-capped, and of different sizes, the smaller ones

being more externally placed than the larger. Scales wanting over by far the greater part of the body, but present as follows:

(1) A row of median scales in front of the dorsal fin.

(2) A set of scales median and lateral, clothing the prolongation of the body-axis along the caudal fin.

(3) A few median scales in front of the lower lobe of the caudal.

(4) A few rows of small thin scales on the flank, immediately behind the shoulder-girdle.

1. Phanerosteon mirabile, *Traquair.* Pl. XXXVII, figs. 4—7.

1881.	Phanerosteon mirabile,	*R. H. Traquair.*	Trans. Roy. Soc. Edinb., vol. xxx, p. 39, pl. iii, figs. 6—8.
1891.	— —	*A. S. Woodward.*	Cat. Foss. Fishes Brit. Mus., pt. ii, p. 476.

Description.—As only one species of *Phanerosteon* can be accurately defined, it is hardly necessary to give a specific diagnosis.

The entire length of the most perfect specimen (Pl. XXXVII, fig. 4) is four inches, but one in the private collection of the writer measures nearly four inches and a quarter; the usual proportion of the head to the total length is as one in four, or four and a half. The cranial roof-bones (fig. 6) are granulated with minute tubercles, which occasionally are confluent. The suspensorium is oblique, the operculum (*op.*) oblong with rounded off postero-superior angle, and showing traces of fine ridges corresponding with the lines of growth; the suboperculum (*s.op.*) is somewhat quadrate-rhomboidal with convex posterior margin. The maxilla (*mx.*), of the typical Palæoniscoid shape, has its postorbital portion marked with fine ridges running parallel with the posterior and superior margins; the dentary margin and infraorbital process are finely tuberculated; the slender mandible displays on its outer surface numerous delicate ridges obliquely impinging on its upper margin. Teeth were not observable on the original specimens, but they are very distinctly seen on two of those now before me, and are smooth, conical and sharp, with distinct enamel-cap, besides being of two sizes, large and small, the large ones being more internally placed. A few branchiostegal plates (*br.*) may be seen under the mandible in most heads, but in no case is the entire series exhibited. The orbit is large, but is, as usual, anteriorly placed, and the ethmoid forms a rounded prominence above the mouth. The bones of the shoulder-girdle present nothing peculiar in their configuration and arrangement.

On the front part of the flank immediately behind the clavicle are several dorso-ventral bands of scales; the exact number of these bands is difficult to ascertain, though there cannot be less, I think, than five. These scales are small, thin, quadrangular,

higher than broad; ganoid externally, though I see no very distinct sculpture, while internally they show traces of the well-known "peg and socket" articulation. Then, in the middle line of the back just in front of the dorsal fin, is a row of scales, oval in shape, slightly imbricating in arrangement, and distinctly sculptured with ridges, which are approximately concentric in disposition. The next scales we meet with are those clothing the prolongation of the body-axis along the upper lobe of the caudal fin, which are exactly as in any other Palæoniscoid fish, and as solid and well-preserved as in any other "ganoid" of similar size from Carboniferous beds. Along the upper margin of this part we find the usual median row of pointed imbricating **V**-scales, and simultaneously with this median row there commences, on each side, a band of lateral ones covering the right and left aspect of the prolonged body-axis, these being minute, acutely lozenge-shaped, and, like the median scales, delicately sculptured with ridges and grooves; this band of lateral scales does not, however, extend to the origin of the caudal fin-rays until the base of the lower lobe is passed. A few imbricating, similarly

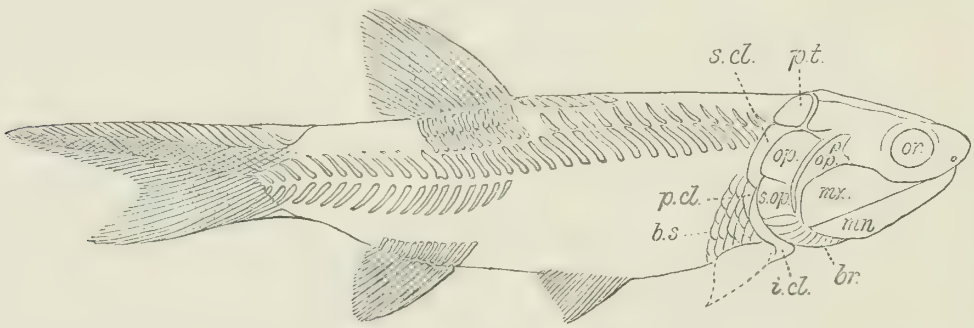


FIG. 9.—Restoration of the skeleton of *Phanerosteon mirabile*, Traquair. Slightly enlarged. *b.s.*, body-scales; *br.*, branchiostegal rays; *i.cl.*, infraclavicle; *mn.*, mandible; *mx.*, maxilla; *op.*, operculum; *or.*, orbit; *p.cl.*, postclavicle; *p.t.*, post-temporal; *pop.*, preoperculum; *s.cl.*, supraclavicle; *s.op.*, suboperculum.

pointed and sculptured median scales may also be seen just in front of the commencement of the lower lobe of the caudal fin.

The almost complete absence of body-scales reveals the internal skeleton in a manner unusually distinct for fishes of this family. There is no trace of vertebral centra, the position of the persistent notochord being indicated by an empty space. This is succeeded on the neural aspect of the anterior part of the body by a series of neurapophyses forming the neural arches, each of which is surmounted by a slender backwardly-inclined neural spine. Posteriorly the neural arches and spines are united into one piece, bifurcated proximally, corresponding hæmal pieces being seen on the opposite aspect. Behind the anal fin, where the hæmal spines are seen supporting the lower lobe of the caudal, they are laterally flattened and dilated at their extremities; further on they are concealed from view by the scales of the caudal body-prolongation. There are no ribs in the abdominal region, nor have I seen with certainty any hæmal pieces or hæmapophyses in this region, though I once supposed I had done so.

The contour of the pectoral fin is not seen in any specimen, as its rays are always

more or less crumpled, but it is very clear that the principal rays were articulated up to their origins. From the same cause the shape of the ventral is also undefinable, but the presence of a triangular-shaped pelvic bone is proved in more than one specimen.

The dorsal fin is elevated and pointed, but has not exactly the same triangular-acuminate form as in such typical genera as *Elonichthys*, etc.; but that is simply due to the longest rays which form the apex of the fin being further back, and those in front, about eight in number, becoming gradually elongated. The exact number of rays cannot be ascertained, but I think there cannot be less than nineteen or twenty. This fin is supported on two sets of interspinous bones, proximal and distal. Those of the proximal set (axonosts) are directly superimposed on the extremities of the neural spines, but they are more numerous and consequently more closely placed; their exact number is not ascertainable. Their distal extremities articulate with the proximal ends of the second set (baseosts), with which they correspond in number; the latter are rather shorter and have both extremities somewhat dilated.

The anal fin has the same form and size as the dorsal, and is supported by interspinous bones of which I can only see one set. These are proportionally longer than the corresponding elements of either of the upper sets, and are slender, enlarged at each extremity, and diminish in length posteriorly, the last being only about half as long as the first. As before it is difficult to determine the exact number of these ossicles.

The caudal is not so deeply bifurcated as in the more typical representatives of the family, or rather we may say that its lower lobe is proportionately not so long. It is, however, very heterocercal and inequilobate, with a very strong upper lobe; its rays, similar in general appearance to those of the dorsal, are, however, finely and minutely dichotomised towards their extremities.

The joints of the rays of all the fins are ganoid, and frequently show longitudinal striations, but I have not, after most careful examination, been able to detect any fulcra on the anterior fin-margins, unless we designate as such the median row of imbricating V-scales which run along the upper margin of the caudal body-prolongation, as in other Palæoniscidæ.

Observations.—So many more or less perfect specimens of this most interesting little fish have been now obtained from the Eskdale fish-beds, that there can be no doubt that the above-described condition of the squamation is normal for the genus and species, and that the condition in question is but one of the many forms of abnormal squamation which we may see arising in this family of Palæoniscidæ, in which the body is usually completely covered with the "regulation" array of rhombic and angular scales. Specialisation has, in fact, produced many variations of form and condition of the scales in the Palæoniscidæ, such as—

(1) The scales may become thin, rounded, deeply imbricating: *Coccolepis*, Agassiz; *Thrissolepis*, A. Fritsch; *Cryphiolepis*, Traquair.

(2) Body may become naked except for a few isolated patches of scales, *e.g.* behind

the shoulder-girdle, in front of the dorsal fin, on the caudal body-prolongation: *Phanerosteon*, Traquair.

(3) Scales may also disappear, except a patch on each side of the abdominal region and a row of >-shaped scales supporting the lateral line canal: *Elpisopholis*, Smith Woodward.

Other Acipenseroid families include genera in which the body-scales are degenerate up to total disappearance, *e.g. Chondrosteus* (fam. Chondrosteidæ), *Polyodon*, *Crossopholis* (fam. Polyodontidæ). Or, as we find in *Acipenser* itself, the typical rhombic ganoid scales may be displaced by scutes. But whatever may be the condition of the scales on the body of the fish, those which clothe the termination of the prolongation of the body-axis are always present and of the same contour. (See the arrangement in *Cryphiolepis*, p. 105, text-figure 4 of this work.)

Geological Position and Locality.—Not uncommon in the fish-beds of Lower Carboniferous age (Calciferous Sandstone Series) exposed in the banks of the River Esk at Glencartholm, near Langholm.

The small, apparently scaleless fish described by A. Fritsch as *Phanerosteon pauper* from the Lower Permian Gas-coal of Bohemia, is not proved to belong to this genus. Certainly the "restored" figure which accompanies his description runs very wide of the mark—the details of the head, vertebral axis and fins not resembling to any sufficient extent the details of the corresponding structures in *Ph. mirabile.*

Genus—Holurus, *Traquair*, 1881.

Generic Characters.—Fusiform: dorsal fin arising behind the middle of the back, not acuminate in front, long-based, extending almost to the commencement of the tail-pedicle; anal fin with a shorter base than the dorsal; caudal strongly heterocercal but not bilobate, triangular, its rays gradually diminishing posteriorly; pectorals unknown; ventrals small, arising slightly in front of the dorsal. Fin-rays in no case dichotomised; fulcra absent. Scales rhomboidal, sculptured; a prominent row of median scales between the occiput and the commencement of the dorsal fin. Teeth small, cylindro-conical.

The structure of the head is decidedly Palæoniscoid, with oblique suspensorium and wide gape; superethmoidal prominence not largely developed.

1. Holurus Parki, *Traquair*. Plate XXXVIII, figs. 1—6.

Holurus Parki, *Traquair*. Trans. Roy. Soc. Edinb., vol. xxx, p. 43, pl. iii, figs. 9—12.

— — *A. S. Woodward*. Cat. Foss. Fishes Brit. Mus., pt. ii, 1891, p. 526.

Length $2\frac{3}{4}$ inches to about 5 inches; greatest depth of body contained about $3\frac{1}{2}$ times, and the length of the head a little over 4 times in the total.

Of the cranial roof-bones, the parietals, squamosals, and frontals may be readily identified, and these are ornamented externally by sharp and delicate tubercles, which sometimes assume an elongated contour. The suspensorium is oblique, the opercular bones seem rather small, and, from defective preservation, their external ornament is not well shown, though on the operculum a few raised striæ similar to those on the other head-plates may be observed. The maxilla has its upper margin as usual cut away in front for the orbit; its broad postorbital portion is ornamented with delicate ridges running parallel with the posterior and superior margins. The mandible is of medium stoutness; its outer surface shows traces of delicate striation. Only very few teeth can, with considerable difficulty, be detected; they are minute and cylindro-conical in shape.

So far as exhibited, the bones of the shoulder-girdle are in every respect conformed

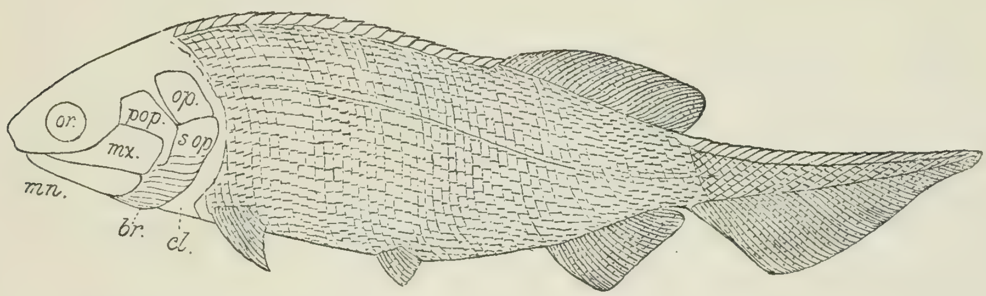


FIG. 10.—*Holurus Parki*, Traquair, outline-restoration. Nat. size. *br.*, branchiostegal rays; *cl.*, clavicular arch; *mn.*, mandible; *mx.*, maxilla; *op.*, operculum; *or.*, orbit; *pop.*, preoperculum; *s.op.*, suboperculum.

according to the usual Palæoniscoid type, and are ornamented with ridges similar to those of the head-bones.

The body-scales (figs. 4, 5), rather small for the size of the fish, are rhomboidal in form, and very ornately sculptured externally with minute and delicate, yet very distinctly marked, ridges and furrows, whose general pattern on the flank-scales (fig. 4) may be described as follows: Below a diagonal running between the antero-superior and postero-inferior angles of the scale, these ridges have a nearly horizontal direction, parallel with the lower margin, some of the lowest also turning up along the anterior margin; while immediately above this diagonal some ridges are seen running downwards and backwards parallel with it, while the uppermost pass backwards parallel with the upper margin and then turn down parallel with the upper part of the posterior one; a few denticulations of the posterior margin are usually seen about the middle. Further back the denticulations disappear, the pattern becomes less marked, the ridges tend to fuse together, and the intervening furrows to degenerate into streaks and punctures, till at last the minute lozenge-shaped scales on the sides of the powerful caudal body-prolongation are nearly smooth. Along the middle line of the back, commencing near

the occiput and extending to the dorsal fin, is a row of large and conspicuous median imbricating scales (fig. 6), each emarginate in front, pointed behind, and becoming more and more acute as the dorsal fin is approached; externally these scales are sculptured with prominent longitudinal ridges. Behind the dorsal fin, acutely pointed scales run along the upper margin of the caudal body-prolongation in the usual manner.

I have not seen the pectoral fin, and only in one specimen are some imperfect remains of a ventral discoverable, this being placed slightly in front of the commencement of the dorsal. The dorsal fin commences behind the top of the arch of the back and extends to the commencement of the tail-pedicle; its longest rays have only about half the length of the base of the fin, and as they become very gradually elongated in front, and remain pretty long behind, a peculiarly rounded and proportionally somewhat long-based form of dorsal is here produced, which is very different from the high triangular-acuminate contour which is prevalent in this family. The anal is somewhat similarly shaped, but has a shorter base, for although the termination of its base is opposite that of the dorsal, it commences a little further behind. The caudal fin, arising from the lower margin of a powerful body-prolongation, is not bifurcated, but assumes a somewhat triangular shape, with the posterior margin only gently concave; its anterior rays being comparatively short, and then gradually diminishing posteriorly. The rays of these fins are nowhere seen to dichotomise, but become simply attenuated distally; they are divided by transverse articulations, which are distant enough to leave the joints longer than broad; externally they are ganoid and distinctly striated in the direction of their length.

No fulcral scales are observable on the anterior margin of any of the fins.

Observations. — In its non-bifurcate caudal and rounded, non-acuminated and proportionally long-based dorsal fin, this remarkable fish, which in 1881 I adopted as the type of a new genus, *Holurus*, contradicts the definition of the Palæoniscidæ given by me at the commencement of this monograph; and in the want of dichotomisation of the fin-rays it also differs from hitherto described genera belonging to this family (with the exception of *Eurylepis*, Newberry). Nevertheless, the structure of the fish being in other respects so decidedly Palæoniscoid, I feel constrained to retain it in the Palæoniscidæ.

The specific name is after the late Mr. Walter Park of Langholm, to whose zeal as a collector the finding of many interesting specimens of the Eskdale fishes was due.

Geological Position and Locality.—Near Glencartholm, Eskdale, in the fish-beds of Lower Carboniferous age (Calciferous Sandstone Series).

Genus—Canobius, *Traquair*, 1881.

Mesopoma (pars), *Traquair.*

Generic Characters.—Body fusiform; caudal fin very heterocercal, deeply cleft, inequilobate, the upper lobe elongated; dorsal and anal fins short-based, triangular-acuminate, nearly opposite each other, the former commencing only very slightly in front of the latter; pectorals and ventrals obscure. Suspensorium nearly vertical; snout rounded, slightly projecting over the mouth; orbit large; gape moderate; dentition unknown. Scales rhomboidal; in some cases there is a median row of large imbricating scales between the occiput and the origin of the dorsal fin.

The type species of this genus of small fishes is *Canobius Ramsayi,* a form which to the general configuration of a Palæoniscid unites a disposition of the suspensorial and opercular apparatus which is almost identical with the condition of these parts in the Platysomid *Eurynotus.* Here again we have a fish which contradicts what I once considered to be an essential character of the Palæoniscidæ—namely the oblique direction of the suspensorium—but which according to its other points of structure it would be hard to exclude from that family.

It will also be convenient to include under *Canobius* several other species of small Palæoniscidæ which resemble the species "*Ramsayi*" in external form as well as in the direction of the suspensorium, although in certain other points of cranial osteology, they differ from that species as well as from each other. Two of these species, viz. *C. pulchellus* and *C. politus,* I accordingly, in 1890, separated under the generic name of *Mesopoma,* adding to the proposed new genus the small species from the West Lothian Oil Shales, which I had previously described as *Rhadinichthys macrocephalus.* However, seeing the difficulty in establishing a satisfactory generic diagnosis for *Mesopoma,* I have come to the conclusion that it is better to withdraw it for the present, and to merge its species in the genus *Canobius.*

Outside the boundaries of the United Kingdom a small Palæoniscid occurs which by Mr. Lawrence M. Lambe is referred to this genus. This is the *Palæoniscus* (*Rhadinichthys*) *modulus* of Sir J. W. Dawson from the Albert Shales (Lower Carboniferous) of New Brunswick, which was referred also to *Palæoniscus* by Newberry, but to *Rhadinichthys* by Smith Woodward and by Eastman. It is said to be about the same length as *Canobius Ramsayi,* and its backwardly placed dorsal fin, with a nearly vertical suspensorium, gives great probability to Mr. Lambe's idea of its generic position.[1]

[1] See J. W. Dawson, 'Canad. Naturalist' (n. ser.), vol. xii, 1878, text-fig., and in 'Arcadian Geology,' Suppl. p. 100, text-fig. 1. A. S. Woodward, 'Cat. Foss. Fishes Brit. Mus.,' pt. ii, 1891, p. 466. C. R. Eastman, 'Geol. Surv. Iowa,' vol. xviii, p. 292. L. A. Lambe, 'Mem. Geol. Surv. Canada,' "Palæozoic Fishes from the Albert Shales of New Brunswick," p. 31, pl. xi, figs. 1—7.

The generic name is taken from Canobie, the district in which the fish-bearing beds of Glencartholm are situated.

1. Canobius Ramsayi, *Traquair.* Plate XXXIX, figs. 1—3.

Specific Characters.—Suspensorium nearly vertical, preoperculum simulating that of *Eurynotus* in being pointed above and below; body-scales comparatively smooth, being marked only with faint ridges and furrows, posterior margins of the scales rarely showing any denticles; a row of especially large median scales runs along the back from the occiput to the dorsal fin.

Description.—Length $2\frac{1}{2}$ to 3 inches; shape shortly fusiform, deep in front and tapering rapidly towards the tail. The length of the head is contained five times, and the greatest depth of the body little more than three times in the total.

The head is short and deep, with a very obtusely rounded snout in front, behind which and nearly right over the mouth is a circular orbit of considerable size. As far

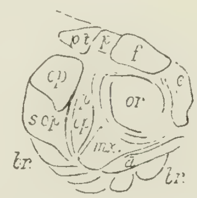


Fig. 11.—Outline-sketch of the principal external head-plates in *Canobius Ramsayi*, Traq. *br.*, branchiostegal rays; *d.*, dentary; other letters as in Fig. 12.

as can be made out, the bones of the cranial roof seem quite Palæoniscoid in their arrangement; their external surfaces are marked with comparatively coarse flattened corrugations. The suspensorium is nearly vertical, being only very slightly inclined backwards; the posterior margin of the opercular flap has a regularly curved semilunar contour. The operculum is small, its anterior margin is nearly vertical, but its inferior one is so oblique as to look as much backwards as downwards, and consequently the posterior margin is considerably shorter than the anterior one, the superior being the shortest of all. It is succeeded below by a suboperculum of a somewhat rhomboidal shape, the acute angles being the postero-superior and the antero-inferior; its vertical depth is fully as great as that of the operculum, and its anterior and posterior margins continue uninterruptedly into the gentle curvature of those of that plate. The preoperculum simulates that of *Eurynotus* and other Platysomidæ, being a narrow plate, with acute superior and inferior angles and a very obtuse anterior one; its long posterior margin, which fits on to the anterior margins of the operculum and suboperculum, is gently convex and nearly vertical in position; the other two short margins are gently concave, the antero-superior being the longer, and fitting on to the posterior margin of an elongated suborbital, while the shorter antero-inferior one is in contact with the

hinder margin of the maxilla. The maxilla forms posteriorly a rather broad and somewhat rhombic-shaped plate, whose anterior angle passes into a narrow process extending on below the orbit. The mandible is small, straight, and slender; below it are seen a few branchiostegal rays or plates. Immediately in front of the antero-superior margin of the preoperculum, and touching the maxilla below, is a narrow and slightly curved suborbital, and again in front of this is a circlet of narrow ossicles, whose number cannot be ascertained, surrounding the entire orbit. The orbit is large, and is situated immediately behind the rounded snout, and above the anterior part of the maxilla.

Like the bones of the cranial roof, those of the face are ornamented externally with tortuous flattened rugæ, except the mandible, which is marked with finer and nearly parallel ridges running from behind forwards with a slight obliquity towards the superior margin.

No teeth are visible on either jaw.

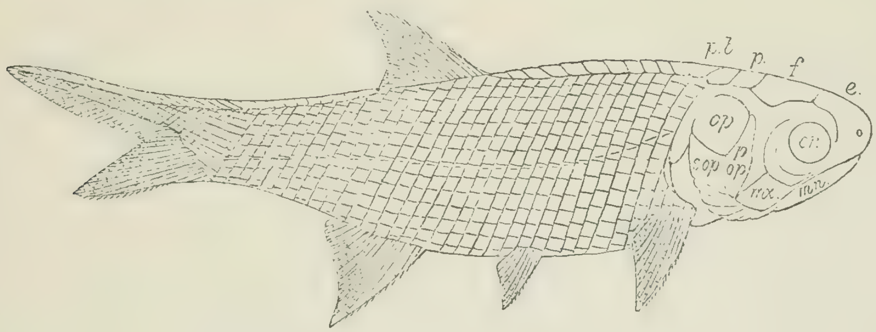


FIG. 12.—Restored outline of *Canobius Ramsayi*, Traquair. Slightly enlarged. *e.*, superethmoid; *f.*, frontal; *mn.*, mandible; *mx.*, maxilla; *op.*, operculum; *or.*, orbit; *p.*, parietal; *p.t.*, post-temporal; *pop.*, preoperculum; *s.op.*, suboperculum.

The bones of the shoulder-girdle are constructed on the usual Palæoniscid type, and are ornamented with flattened ridges like those of the head.

The scales of the body are arranged as usual in dorso-ventral bands, of which 34 may be counted between the shoulder-girdle and the commencement of the lower lobe of the caudal fin. They are of moderate size, largest on the anterior part of the flank, smaller dorsally and posteriorly, and low and narrow on the belly. A row of especially large, median, imbricating scales runs along the back from the occiput to the commencement of the dorsal fin. These median scales are marked each with a few tolerably well-pronounced longitudinal ridges, as are also the imbricating V-scales of the upper caudal lobe; but the body-scales in general are comparatively smooth, being marked only with faint ridges and furrows, proceeding somewhat diagonally from before backwards and downwards, and which usually stop short before they arrive at the posterior margin of the scale; in many specimens these striæ are nearly entirely obsolete on the scales below the lateral line. There may also often be observed on the flank-scales a number of very delicate vertical grooves close to and parallel with the anterior margin of the ganoid

area. For the most part the posterior margins of all the scales are even and entire, denticulations being only occasionally, and indeed rarely visible.

The pectoral fin is shown in one specimen; it is small and composed of numerous delicate rays which seem to be jointed for a considerable part of their length. I have not seen the ventral in any specimen which I have examined. The dorsal is situated far back so as to be situated nearly opposite the anal; both fins are short-based, triangular-acuminate in shape, and are composed of delicate, brilliantly ganoid and distantly articulated rays. The caudal is very heterocercal, deeply cleft and inequilobate, the upper lobe being about twice the length of the lower, and nearly equalling one-third of the entire length of the fish; its delicate rays are similar in character to those of the dorsal and anal. Delicate fulcra are visible on the anterior margins of all the fins.

Geological Position and Locality.—Not uncommon in the fish-bearing beds of Calciferous Sandstone age (Lower Carboniferous) exposed in the banks of the River Esk near Glencartholm.

2. Canobius elegantulus, *Traquair*. Plate XXXIX, figs. 4—6.

Canobius elegantulus, *Traquair*. Trans. Roy. Soc. Edinb., vol. xxx, 1881, p. 47, pl. v, figs. 1—4.
— — *A. S. Woodward*. Cat. Foss. Fishes Brit. Mus., pt. ii, 1891, p. 431.

Specific Characters.—Like *C. Ramsayi* in general form and dimensions; flank-scales having the greater part of the exposed surface sculptured with five or six prominent straight ridges running across the scale in a direction nearly parallel with the upper and lower margins, and ending in sharp points on the posterior margin. A median row of specially large imbricating scales extends from the occiput to the origin of the dorsal fin.

Description.—Length from 2 to $2\frac{3}{4}$ inches; length of head contained nearly five times, the greatest depth of the body about three and a half times in the total. Shape shortly fusiform, rapidly tapering towards the tail, the upper lobe of the caudal fin being elongated. The head is short and deep.

The cranial roof-bones, which are Palæoniscid in form and arrangement, are marked externally with tolerably sharp, tortuous, and often reticulating ridges. The direction of the suspensorium is nearly vertical, the posterior margin of the opercular flap evenly rounded. The operculum is a quadrate plate with rounded-off postero-superior angle, but its lower margin is not quite so oblique as in the last-described species; it is succeeded below by a suboperculum of nearly the same size, but having its postero-inferior angle correspondingly rounded off. The preoperculum is very difficult of detection, but seems to me to be represented by a very narrow plate in front of the operculum and suboperculum. In front of this there is, instead of the one long vertical suborbital, which we saw in *C. Ramsayi*, a chain of three or four short ones, in front

of which again there appears to be a circle of long, narrow, curved ossicles, whose number is uncertain, apparently surrounding the entire orbit, which is proportionally very large, and seems indeed to occupy almost the entire space between the snout and the opercular bones. There is considerable difficulty in making out the exact form of the jaw-bones. One thing is, however, certain—viz., that the maxilla has not the shape usually found in the Palæoniscidæ, but has a somewhat triangular form more resembling that in certain Platysomidæ, such as *Mesolepis*, etc. The gape seems to be small, and the mandible delicate; no teeth can be seen on either jaw. The bones of the face are, like those of the cranial roof, sculptured externally with tolerably fine and occasionally flattened tortuous rugæ.

The bones of the shoulder-girdle present nothing calling for special remark; their external surfaces are sculptured in a manner similar to the bones of the head.

The scales are moderate in size and mostly of the usual rhomboidal form all over the body; but there is a median row of specially large imbricating scales of a more or less oval shape extending from the occiput to the origin of the dorsal fin, besides the

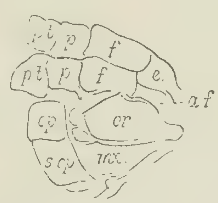


Fig. 13.—Outline-sketch of the principal external head-plates in *Canobius elegantulus*, Traq. The sub- and circum-orbital plates have been omitted owing to their not being preserved with sufficient distinctness. *af.*, anterior frontal or dermal ectoethmoid; other letters as in Fig. 12.

usual V-scales along the upper margin of the tail. There are about thirty oblique dorso-ventral bands of scales from the shoulder-girdle to the commencement of the lower lobe of the caudal fin. The ganoid area of the flank-scales shows, in the first place, a few delicate yet sharp vertical grooves close to and parallel with the anterior margin, succeeding which the greater part of the exposed surface is sculptured with five or six prominent straight ridges running across the scale, nearly parallel with the upper and lower margins, ending in sharp points on the posterior margin. A very similar sculpture pervades the entire squamation, though the corresponding ridges on the median scales of the back are somewhat convergent, and the minute lozenge-shaped scales of the caudal body-prolongation are nearly smooth.

I have not seen either the pectoral or the ventral fins. The dorsal and anal are nearly opposite each other, the former commencing only a little more anteriorly; both fins are very similar in shape, being short-based and triangular-acuminate; each contains about twenty rays, which are delicate, smooth, distantly articulated, and dichotomising towards their extremities. The caudal is very heterocercal, deeply cleft, and inequilobate, the upper lobe being elongated; the rays are delicate, smooth, and distantly articulated;

the lower lobe contains about fourteen rays, but the number of those in the upper one cannot be accurately ascertained.

Observations.—This very decidedly marked species closely resembles the foregoing in the general form of the body and fins, in the shortness of the head with its large orbit, and in the direction of the suspensorium; but it may at the first glance be distinguished by the bold and peculiar sculpture of the scales; the ridges on the head-bones are likewise different in character, and the dorsal and anal fins seem to be somewhat more anteriorly placed. In addition to these diagnostic characters, an examination of the head reveals certain osteological differences, which might easily be considered to be of generic importance. Of these differences the most striking is the form of the maxilla, which here (see Text-fig. 12) assumes a somewhat triangular form, reminding us of that bone in the Platysomid *Mesolepis,* while in *Canobius Ramsayi* it is not so much modified from the ordinary Palæoniscid type. Our knowledge of the osteology of the head of *C. elegantulus* being still by no means complete, it will, I think, be at present more convenient to be satisfied with the more obvious resemblances of general configuration, and to leave this very pretty species, provisionally at least, in the same genus with *Canobius Ramsayi.*

Geological Position and Locality.—Not uncommon in the Lower Carboniferous (Calciferous Sandstone) fish-beds at Glencartholm, Eskdale.

3. Canobius pulchellus, *Traquair.* Plate XXXIX, figs. 7—11.

Canobius pulchellus, *Traquair.* Trans. Roy. Soc. Edinb., vol. xxx, 1881, p. 51, pl. v, figs. 9—13.
— — *A. S. Woodward.* Cat. Foss. Fishes Brit. Mus., pt. ii, 1891, p. 432.
Mesopoma pulchellum, *Traquair.* Ann. Mag. Nat. Hist. [6], vol. vi, 1890, p. 493.

Specific Characters.—Varying in length from $2\frac{1}{2}$ to nearly 4 inches; cranial osteology more typically Palæoniscid than in the two previously described species. Outer surfaces of cranial plates tuberculated, facial plates striated externally. Scales highly ornate, there being first a band of ridges and furrows parallel with and close to the anterior margin, then flexed below so as to become parallel with the lower margin and with the set of transverse ridges and furrows which fill up the space above them on the inferior, posterior and superior parts of the exposed surface of the scale (see figs. 8, 9, and 11 on Pl. XXXIX). A median row of conspicuous scales extends from the occiput to the commencement of the dorsal fin.

Description.—The length of one absolutely entire specimen is $2\frac{1}{8}$ inches; that of a larger specimen deficient in the extremity of the upper lobe of the caudal fin is $3\frac{1}{4}$ inches. The length of the latter specimen when entire would probably amount to $\frac{1}{4}$ inch more.

The length of the head is pretty nearly equal to the greatest depth of the body and is contained slightly more than $4\frac{1}{2}$ times in the total. The shape is fusiform, the body being deepest midway between the head and the commencement of the dorsal fin, and thence tapering rapidly and elegantly towards the tail-pedicle.

The cranial roof-bones are ornamented with small rounded tubercles, which sometimes tend to become elongated, especially on the posterior or parietal region. The ethmoidal region forms a rounded projection over the mouth; the orbit is large and anteriorly placed. The suspensorium is more oblique than in *Canobius Ramsayi* or in *C. elegantulus*, but less so than in the typical Palæoniscidæ; the posterior margins of the opercular and subopercular plates pass into each other so as to form a continuous gently curved line. The operculum is a small oblong plate with rounded inferior margin and postero-inferior angle; the suboperculum, nearly equalling the operculum in size, has its upper margin correspondingly concave, and its postero-superior angle slightly produced upwards. The preoperculum cannot be very distinctly made out, but I rather suspect that it more resembles that bone in typical Palæoniscidæ than in *Canobius Ramsayi.* The maxilla is elongated and its shape is decidedly Palæoniscid, though its broad posterior part is not so suddenly cut away from the orbit as in more typical forms; the mandible is slender and tapering, but neither in it nor in the maxilla are any teeth discernible. All the facial bones are ornamented with delicate ridges, usually flexuous, though on the mandible they are pretty straight, parallel with the inferior margin and touching the superior one at acute angles, owing to the tapering shape of the bone. On the narrow infraorbital part of the maxilla the ridges pass into rows of tubercles, which pass obliquely downwards and backwards or, conversely, upwards and forwards.

The scales are moderate in size; the median row of scales between the head and dorsal fin is rather conspicuous, but not so much as in *C. Ramsayi* and *C. elegantulus.* Taking a flank-scale as an example, the covered area is narrow, the exposed one is ganoid and sculptured with closely-set bold ridges and furrows, forming a pattern, which in its main features is characteristic of a large number of Palæoniscidæ. First, we have a few vertical ridges running close to and parallel with the anterior margin, and then turning round below to run backwards parallel with the inferior one, the rest of the area being occupied with ridges which run parallel with the superior and inferior margins, but of course directed against the vertical portions of the first-mentioned set. Some amount of waviness is frequently observed in these ridges, and, where they come to the posterior margin of the scale, they end in sharp denticulations. On other parts of the body, such as the back, belly and tail, the ridges tend to pass into one set, which traverse the scales somewhat diagonally from before backwards.

I have not observed the pectoral fins; the ventral is preserved in one specimen, but shows nothing peculiar in its structure. The dorsal and anal are nearly opposite each other, the former commencing an almost inappreciable distance in advance of the latter;

both fins are well developed, triangular-acuminate, composed of rather stout smooth rays which dichotomise towards their extremities and are divided by tolerably distant articulations. The caudal is deeply cleft, very heterocercal and inequilobate, the upper lobe appearing produced; its rays are similar in character to those of the dorsal and anal. Very distinct fulcra are seen along the anterior margins of all the fins described.

Several examples have occurred of what seems to me to be only a variety of the above described form, the only appreciable difference being the more delicate markings on the scales (Pl. XXXIX, figs. 10, 11).

Observations.—I know of no previously-described fish with which the present species can be confounded. In general contour it resembles *Canobius Ramsayi* and *C. elegantulus*, but it may at once be distinguished from both by its scale-markings as well as by the more typically Palæoniscoid configuration of its facial bones. In the form of the opercular bones and the direction of the suspensorium, a condition is presented which is somewhat intermediate between that in *Canobius Ramsayi* and in ordinary Palæoniscidæ, and which did induce me to make a separate genus "*Mesopoma*" for this and the three following species. But considering that so much still remains to be learned concerning the more minute characters of these small fishes, it is perhaps better to avoid premature multiplication of genera by including them provisionally in *Canobius*, to which they certainly bear a greater general resemblance than to any other generic form.

Geological Position and Locality.—Near Glencartholm, Eskdale, in the fish-bearing beds of Lower Carboniferous age exposed in the banks of the River Esk.

4. Canobius politus, *Traquair*. Plate XXXIX, figs. 12—16.

Canobius politus, *Traquair*. Trans. Roy. Soc. Edinb., vol. xxx, 1881, p. 83, pl. v, figs. 14—16.
Mesopoma politum, *Traquair*. Ann. Mag. Nat. Hist. [6], vol. vi, 1890, p. 493.
Canobius politus, *A. S. Woodward*. Cat. Foss. Fishes Brit. Mus., pt. ii, p. 433.

Specific Characters.—Attaining a length of 3 inches, sometimes a little more, the general proportions being those of the genus. Flank-scales mostly smooth and sharply denticulated along the posterior border; sometimes showing traces of transverse striation; median scales of the back, between the head and the origin of the dorsal fin, not specially large and prominent, excepting a few just in front of that fin.

Description.—The type specimen, deficient in the caudal extremity, is represented in Pl. XXXIX, fig. 12. Subsequent work by various collectors has, however, provided a good many with tails, of which two belonging to the British Museum are shown in figs. 13 and 14 of the same plate.

The shape is fusiform, the dorsal and ventral margins being pretty evenly and elegantly curved. The length of the head is contained approximately twice in the distance between the tip of the snout and the commencement of the dorsal fin and thrice up to the origin of the caudal.

The cranial roof-bones are ornamented with comparatively coarse ridges, frequently, and in some specimens more than others, becoming broken up into round or elongated tubercles. The snout forms a rounded prominence over the mouth, and behind it is placed the orbit, of considerable size. The suspensorium is only very slightly oblique in its direction; the operculum and suboperculum are nearly of equal size, and when their external ornament is seen it is more or less of a striated character. The maxilla apparently resembles that of the preceding species in form, having a short, broad posterior portion passing into a narrow tapering process which runs forwards below the orbit. The mandible is short, stout, and straight, and ornamented with longitudinal and oblique ridges, which are somewhat finer than those on most of the other bones of the head; on its margin several minute sharp conical teeth may be distinguished.

The scales (figs. 15, 16) are of moderate size, largest and least oblique on the front of the flank, and diminishing in size posteriorly and towards the dorsal and ventral margins. Along the belly, between the pectoral and anal fins, the scales are also low and narrow; but those along the middle line of the back are not specially large or prominent, excepting a few just in front of the dorsal fin. Over nearly the whole of the body the scales are almost smooth on their exposed surfaces—only on the back near the middle line do we observe a few grooved striations, while on the flank-scales of some specimens we also observe some faint indications of obsolete ridges passing with some slight obliquity from before backwards and downwards. The posterior margins of the scales of the side of the body are, as far back as the tail-pedicle, marked with tolerably well-marked denticulations.

In the type specimen (fig. 12) a small pectoral fin is visible, but unfortunately its state of preservation is not such as to render a minute description warrantable: remains of the ventral are also seen midway between the pectoral and anal. The dorsal fin commences only very slightly in front of the anal; both are of the usual acuminate form, with tolerably delicate rays, which are smooth, distantly articulated and dichotomising towards their terminations; well-developed fulcra are seen along their anterior margins. The caudal fin is well seen in figs. 13 and 14; it is of the usual heterocercal deeply divided contour, and its rays are similar in character to those of the dorsal and anal.

Observations.—This species is evidently very closely allied to the preceding, from which it may, however, at once be distinguished by the smoothness of its scales and by the greater coarseness of the ornament on the cranial roof-bones, which, moreover, always partakes more or less of a ridged character; the suspensorium seems also more nearly vertical in its direction.

Geological Position and Locality.—Near Glencartholm, Eskdale, in the fish-bearing shales of Calciferous Sandstone (Lower Carboniferous) age. The original specimens were collected by the Geological Survey of Scotland.

5. Canobius macrocephalus, *Traquair*, sp. Plate XL, figs. 1—4.

Rhadinichthys macrocephalus, *Traquair*. Proc. Roy. Soc. Edinb., vol. xvii, 1890, p. 398.
Mesopoma macrocephalum, *Traquair*. Ann. Mag. Nat. Hist. [6], 1890, vol. vi, p. 493.
Canobius macrocephalus, *A. S. Woodward*. Cat. Foss. Fishes Brit. Mus., pt. ii, p. 433.

Specific Characters.—Attaining a length of 4 inches; length of head, which is proportionally short and deep, contained a little over four times in the total; depth of body at shoulder equal to twice that of tail-pedicle, so that the form of the fish tapers conspicuously from before backwards; scales mostly smooth, with very minute denticulations; no specially large scale in the middle line of the back; cranial roof-bones tuberculo-striate; suspensorium nearly vertical in direction.

Description.—Owing to the frequent distortions to which these fishes have been subjected in the process of fossilisation, it is difficult to lay down their proportions with perfect accuracy; however, we may specially note the large size of the head and the tapering form of the body from the shoulder to the tail-pedicle.

The cranial roof-bones have a tuberculo-striated ornament; the orbit is large; the suspensorium nearly vertical. No good view is to be had of the facial bones in spite of the large number of specimens which have been collected; nevertheless the form of the maxilla and the presence of branchiostegal rays or plates may be noted in some examples.

The dorsal fin commences at or about twice the length of the head from the tip of the snout, and is of the usual acuminate shape; as is also the anal, the commencement of which is only a very small distance behind it. The rays of both fins are rather distantly articulated, the joints being either perfectly smooth or having at most a single fine longitudinal furrow. The caudal is small, but completely heterocercal, and deeply cleft; its rays are like those of the dorsal and anal.

The pectoral is seen in one specimen; it is small, with very few rays, the careful examination of which leads to the conclusion that, as in *Rhadinichthys*, the principal rays were unarticulated till towards their distal extremities. Traces of the ventral are seen just in the middle between the pectoral and the anal.

The scales are of moderate size, largest on the flank, and becoming smaller on the belly, the caudal extremity, and the back, although there is no median row of enlarged

PLATE XXXVI.

(The cost of this plate has been defrayed by the Carnegie Trust for the Universities of Scotland.)

Fig.

1. *Rhadinichthys* (?) *angustulus*, Traquair; natural size. From the Lower Carboniferous (Calciferous Sandstone Series), Glencartholm, Eskdale. Specimen in the Collection of the Geological Survey of Scotland.
2. Scales from another specimen of the same species, from the same horizon and locality, magnified six diameters. Also in the Collection of the Geological Survey of Scotland.
3. *Myriolepis Hibernica*, Traquair. Specimen deficient posteriorly, but showing all the fins except the caudal, natural size. *R. pect.*, right pectoral; *r. vent.*, right ventral; *d.*, dorsal; *a.*, anal. From the Coal Measures, Jarrow Colliery, Co. Kilkenny, Ireland. In the Museum of Practical Geology, Jermyn Street, London.

6/7

Fig. 2.

Fig 1.

Fig. 3.

Figs. 1 & 2. R. H. Traquair.
Fig. 3. J. Green.

J. Green in lap.

PLATE XXXVII.

(The cost of this plate has been defrayed by the Carnegie Trust for the Universities of Scotland.)

FIG.

1. *Myriolepis Hibernica*, Traquair. Entire specimen showing head and all the fins. Natural size. From the Coal Measures of Co. Kilkenny, Ireland. Specimen in the British Museum (P. 9604).
2. Scale-ornament of the same specimen, magnified five diameters. After Smith Woodward.
3. Fin-rays of the same specimen, magnified five diameters. After Smith Woodward.
4. *Phanerosteon mirabile*, Traquair. A fine entire specimen from the Lower Carboniferous of Glencartholm, Eskdale. Natural size. In the Collection of the Geological Survey of Scotland.
5. One of the original type specimens from the same horizon and locality. Natural size. Collection of the Geological Survey of Scotland.
6. Head of another of the original specimens from the same horizon and locality, in the Collection of the Geological Survey of Scotland. Magnified two-and-a-half times. *br.*, branchiostegal rays; *cl.*, clavicle; *i.cl.*, infraclavicle; *mx.*, maxilla; *o.*, orbit; *op.*, operculum; *pt.*, post-temporal; *s.op.*, suboperculum.
7. Tail deficient in the extremity of the lower lobe of the caudal fin, also in the Collection of the Geological Survey of Scotland. Magnified two-and-a-half times.

5/1

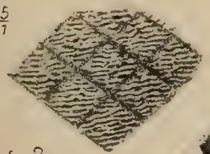


Fig. 2

5/1

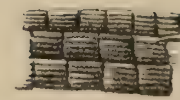


Fig. 3

Fig. 1.

Fig. 4.

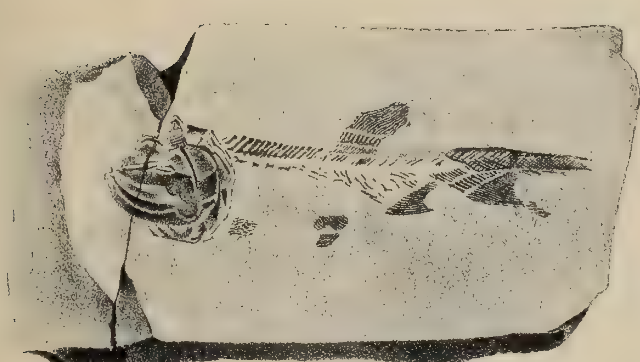


Fig. 5.

2½/1

Fig. 6.

2½/1

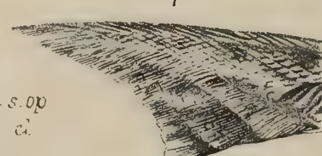


Fig. 7.

Figs. 1 & 4. J. Green.
Figs. 2 & 3. J. Green after A. S. Woodward.
Figs 5, 6, 7. R. H. Traquair.

J. Green in lap.

PLATE XXXVIII.

(The cost of this plate has been defrayed by the Carnegie Trust for the Universities of Scotland.)

Fig.

1. *Holurus Parki*, Traquair. Entire specimen, natural size; showing especially the head and the dorsal and caudal fins. From the Lower Carboniferous (Calciferous Sandstone Series), Glencartholm, Eskdale. Royal Scottish Museum, Edinburgh.
2. Another and somewhat larger specimen of the same species, also represented of the natural size. From the same horizon and locality. In the Royal Scottish Museum.
3. One of the type specimens, previously figured by the author in 'Trans. Roy. Soc. Edinburgh,' vol. xxx, pl. iii, fig. 9. Natural size. In the Collection of the Geological Survey of Scotland. Same horizon and locality.
4. Flank-scale, magnified six diameters.
5. Scale further back, also magnified six diameters.
6. Median dorsal scales, also magnified six diameters.

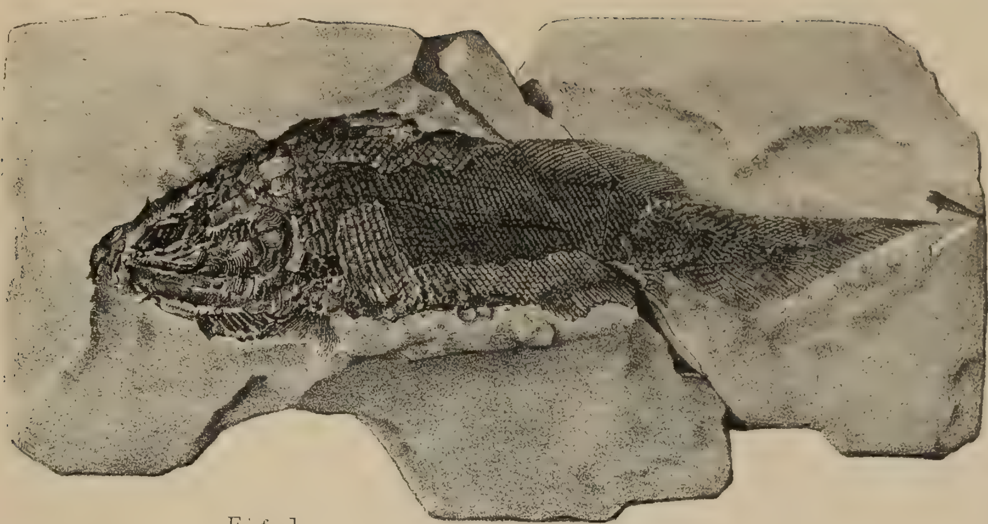


Fig. 1.

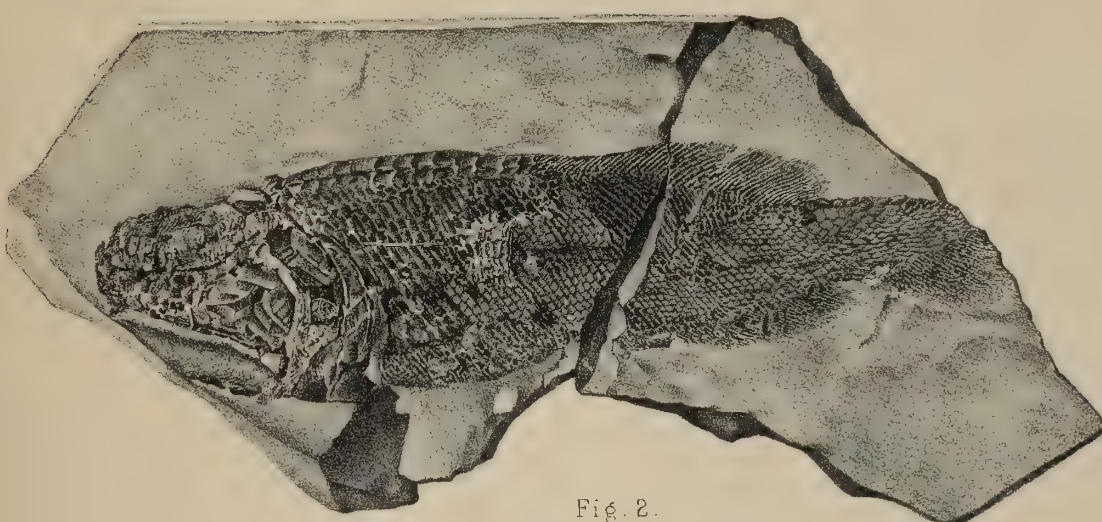


Fig. 2.

Fig. 3.

Fig. 4.

6/1

Fig. 6

4/1

6/1

Fig. 5.

Figs. 1 & 2. J. Green
Fig. 3, P. A. Traquair
Figs. 4-6. R. H. Traquair.

J. Green in lap.

PLATE XL.

(The cost of this plate has been defrayed by the Carnegie Trust for the Universities of Scotland.)

(The cost of this plate has been defrayed by the Carnegie Trust for the Universities of Scotland.)

FIG.

1. *Canobius macrocephalus,* Traquair; type specimen, natural size. From the Pumpherston Oil-shale, "Curly Seam," worked in the Broxburn District, West Lothian. Specimen in the Collection of the Author.
2. Another specimen from the same horizon and locality, natural size. In the Royal Scottish Museum, Edinburgh.
3. Specimen showing well the bands of scales on the body, natural size. From the same horizon and locality. In the Royal Scottish Museum.
4. Young specimen, natural size. Same horizon and locality; also in the Royal Scottish Museum.
5. *Canobius crassus,* Traquair; counterpart, or imprint, of unique specimen, natural size. From Glencartholm, Eskdale, in the Collection of the Author.

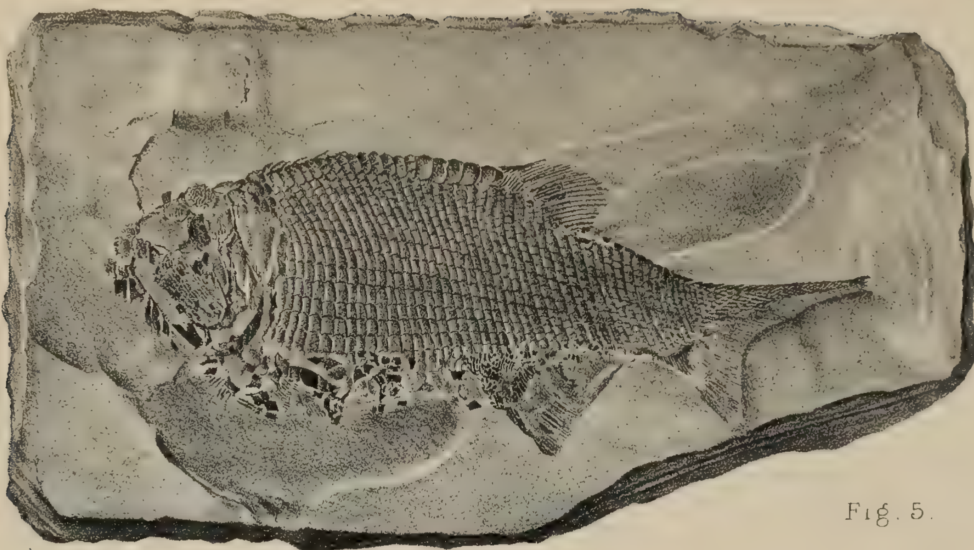


Fig. 5.

Fig. 4.

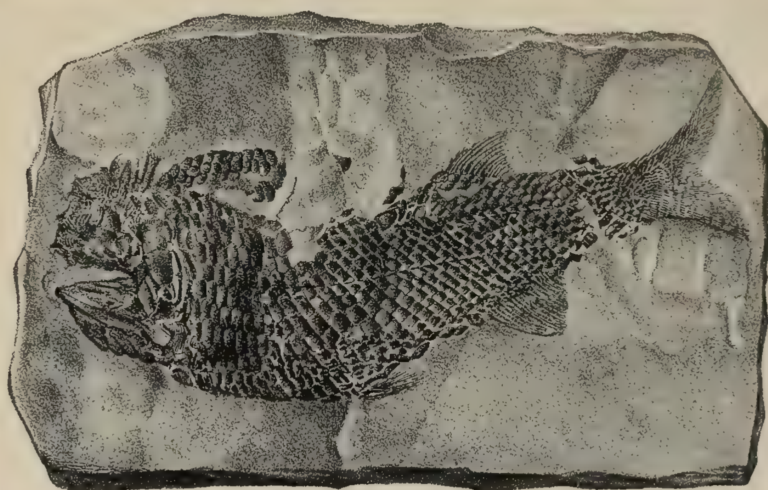


Fig. 2.

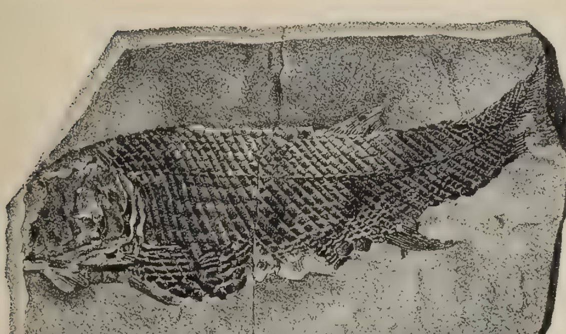


Fig. 3.

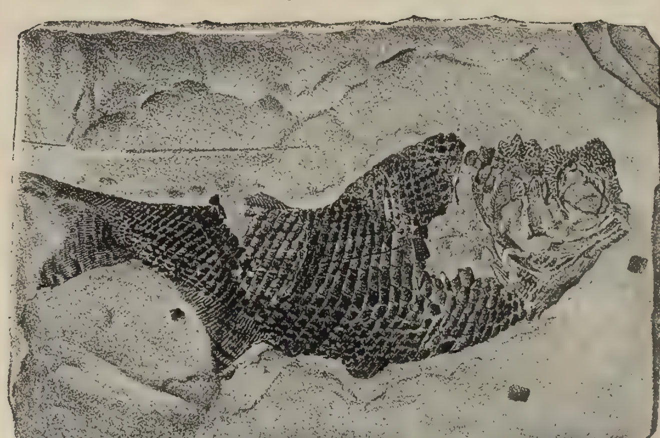


Fig. 1.

J. Green del. J. Green in lap

Palæontographical Society, 1911.

THE FOSSIL FISHES OF THE ENGLISH CHALK.

BY

ARTHUR SMITH WOODWARD, LL.D., F.R.S.,

KEEPER OF THE DEPARTMENT OF GEOLOGY IN THE BRITISH MUSEUM; SECRETARY OF THE PALÆONTOGRAPHICAL SOCIETY.

PART VII.

Pages 225—264; Plates XLVII—LIV;
Title Page and Index.

LONDON:
PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.
February, 1912.

PRINTED BY ADLARD AND SON, LONDON AND DORKING.

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1911.

LONDON:

MDCCCCXII.

THE FOSSIL FISHES OF THE ENGLISH CHALK.

ORDER OF BINDING AND DATES OF PUBLICATION.

PAGES	PLATES	ISSUED IN VOL. FOR YEAR	PUBLISHED
Title-page and Index (i—viii)		1911	February, 1912
1—56	I—XIII	1902	December, 1902
57—96	XIV—XX	1903	December, 1903
97—128	XXI—XXVI	1907	December, 1907
129—152	XXVII—XXXII	1908	December, 1908
153—184	XXXIII—XXXVIII	1909	December, 1909
185—224	XXXIX—XLVI	1910	January, 1911
225—264	XLVII—LIV	1911	February, 1912

THE

FOSSIL FISHES

OF THE

ENGLISH CHALK.

BY

ARTHUR SMITH WOODWARD, LL.D., F.R.S.,

KEEPER OF THE DEPARTMENT OF GEOLOGY IN THE BRITISH MUSEUM; SECRETARY OF THE PALÆONTOGRAPHICAL SOCIETY.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1902—1912.

ADLARD AND SON, IMPR., LONDON AND DORKING.

SYSTEMATIC INDEX.

SYSTEMATIC INDEX.

SUPPLEMENT.

LIST OF TEXT-FIGURES.

ERRATA.

P. 101, fig. 28. *For* "one fifth" *read* "one half."

P. 181, line 9. *Add* "Plate XXXIX, fig. 3."

P. 183, line 34. *For* "Plate XXXIX, fig. 3" *read* "Pl. XL, figs. 4, 5."

Family MYLIOBATIDÆ.

Genus **PTYCHODUS,** Agassiz.

Ptychodus, L. Agassiz, Poiss. Foss., Feuill., 1835, p. 54 (name only), and vol. iii, 1839, p. 150.
Aulodus, F. Dixon, Geol. Sussex, 1850, p. 366.
Sporetodus, E. D. Cope, Bull. U.S. Geol. Surv. Territ., i, no. 2, 1874, p. 47.
Hemiptychodus, O. Jaekel, Eocänen Selachier Monte Bolca, 1894, p. 137.

Generic Characters.—Teeth quadrate in shape, with more or less elevated crown, which overhangs to some extent and is separated from the root by a

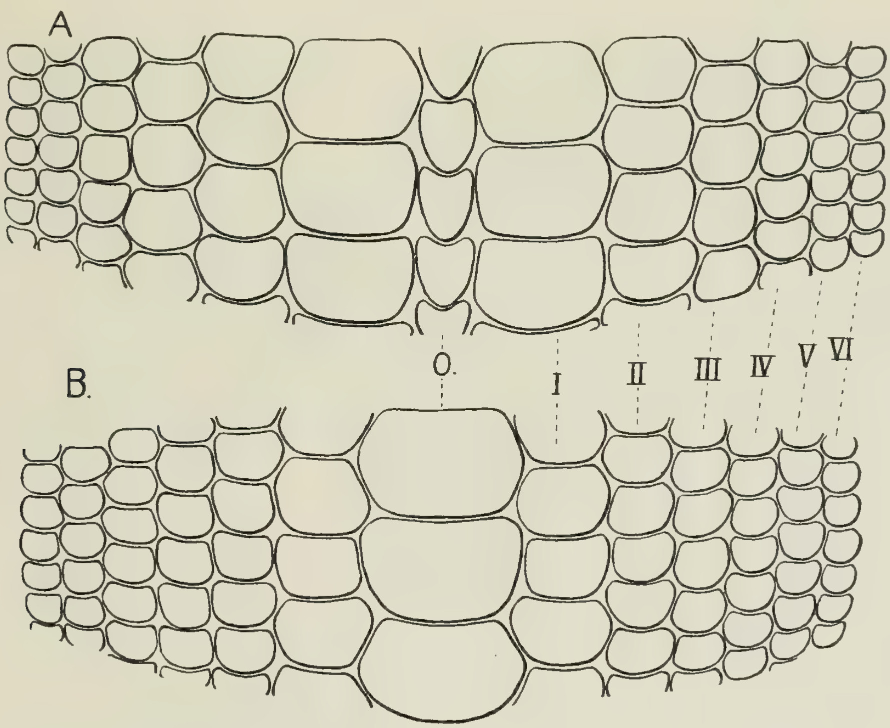


FIG. 69. *Ptychodus;* diagram of arrangement of teeth in upper (A) and lower (B) jaws. O, middle row; I—VI, paired lateral rows.

constriction; crown enamelled, and marked with transverse or radiating ridges, surrounded by a more finely marked marginal area of variable width; attached surface of root smooth, not grooved. Teeth arranged as a close pavement in longitudinal rows on the symphysial portion of the jaws (Text-fig. 69); a median row in one jaw (probably upper) of relatively small teeth, flanked by several symmetrical pairs of rows which diminish in size laterally; the median row in the opposing jaw (probably lower) comprising the largest teeth, and the flanking paired rows gradually diminishing in size laterally. Vertebral centra in the form of well-calcified, short, biconcave discs, each strengthened by delicate concentric laminæ.

Type Species.—*Ptychodus mammillaris*, from the English Chalk.

Remarks.—This is an exclusively Upper Cretaceous genus, of which most of the species are known only by scattered teeth. The plan of arrangement of the dentition has been discovered in *P. decurrens* (Pl. LI, figs. 4–6, 9–12; text-figs. 70, 71, 76, 77), and in *P. mortoni*; while the jaw-cartilages and vertebral centra have hitherto been observed only in the former species.

The number of teeth in each jaw is very great, and the new teeth from behind increase only slowly in size. Williston[1] has counted about 550 teeth in a well-preserved upper dentition of *P. mortoni*, where they are arranged in seventeen antero-posterior rows; and he estimates that the total number cannot have been

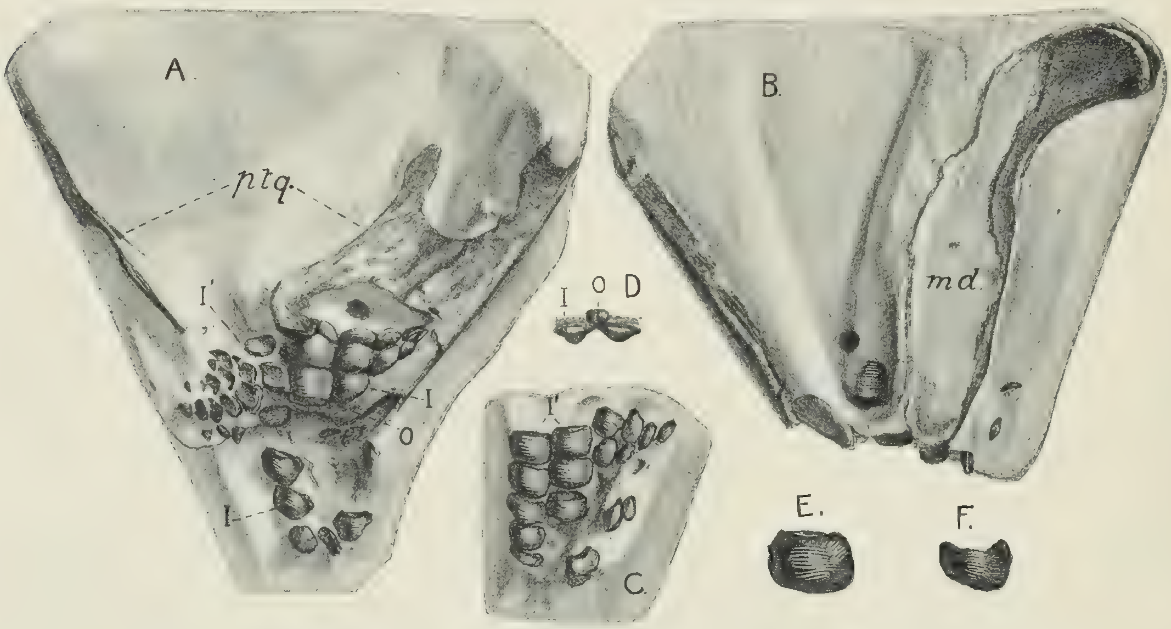


FIG. 70. *Ptychodus decurrens*, Agassiz; remains of jaws with dentition in small block of chalk, slightly reduced in size.—Zone of *Holaster subglobosus*; Glynde, Sussex. Willett Collection, Brighton Museum. A. Upper aspect, showing extent of decayed symphysis; B. lower aspect, without symphysis; C. part of upper dentition, oral aspect; D. posterior end-view of middle upper teeth; E, F. posterior and anterior teeth respectively of the left upper inner paired row. *md.*, mandible; *ptq.*, pieces of cartilage of upper jaw (pterygo-quadrate); O′., I′., teeth of upper middle and inner paired rows; O., I., teeth of lower middle and inner paired rows. From Quart. Journ. Geol. Soc., vol. lx (1904).

less than 600. They are fewer in *P. decurrens*, where there is no evidence of more than thirteen or fifteen rows. In two specimens referable to the latter species (Text-figs. 70, 76), some teeth of both jaws are actually seen in their natural position; while in one of the specimens (Text-fig. 70), the dentition is shown to be restricted to the long symphysial portion of the jaw, as represented in the restored sketch, Text-fig. 71. The rami of the jaw meet in an acute angle at their elongated symphysis, and the cartilages resemble those of existing Elasmobranchs in being only superficially calcified.

[1] S. W. Williston, "Cretaceous Fishes," Univ. Geol. Surv. Kansas, vol. vi (1900), p. 239, pls. xxv–xxvii.

The microscopic structure of the teeth has already been described by Agassiz[1] and Owen.[2] They always consist of vaso-dentine, with a moderately thick layer of gano-dentine on the coronal surface; and they have no internal cavity (Text-fig. 72). The vaso-dentine of the root is of very open texture, with the medullary canals irregularly vermiculating; while that of the crown is traversed by canals which rise towards the surface, diverging from each other and branching dichotomously, so as to maintain a direction vertical to the surface towards which they proceed. From each medullary canal minute calcigerous tubules radiate

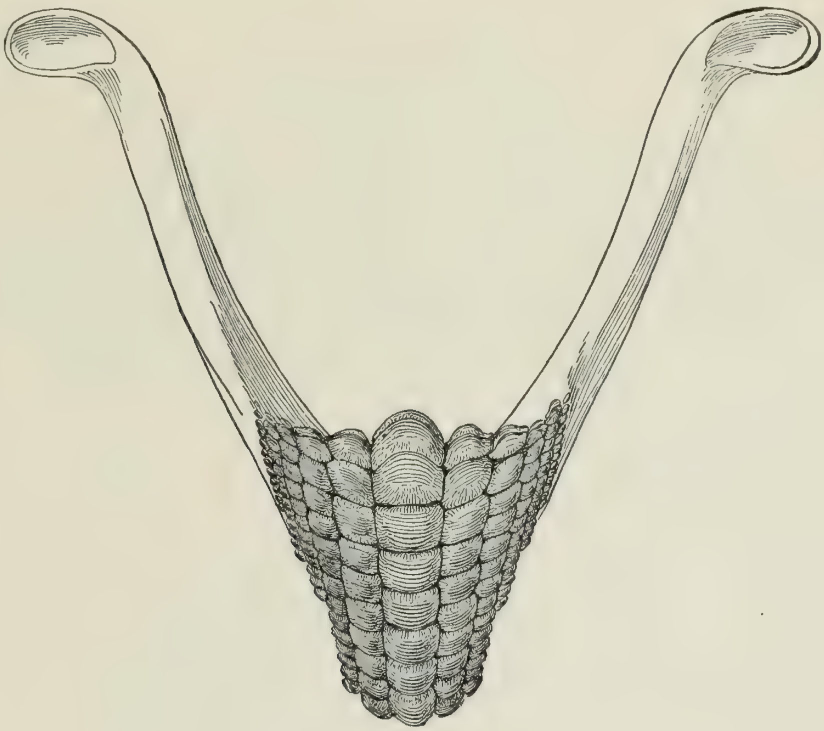


Fig. 71. *Ptychodus decurrens,* Agassiz; diagram of mandible, oral aspect, showing arrangement of teeth on symphysis, based on specimen shown in Text-fig. 70. From Quart. Journ. Geol. Soc., vol. lx (1904).

outwards, those near the base at right-angles, those nearer the surface at more and more acute angles, until the canal itself terminates just below the translucent gano-dentine in a tuft of such tubules. The calcigerous tubules are more wavy than the medullary canals, rapidly branch and subdivide to extreme minuteness, and finally terminate by anastomosing with each other. A transverse section (Text-fig. 72 B) shows that the medullary canals do not form the centres of well-separated prismatic denticles, such as are always distinct in the teeth of the existing *Myliobatis*, *Rhinoptera*, and *Ætobatis*.

Teeth occasionally occur in which the enamel-layer has been destroyed either

[1] L. Agassiz, Poiss. Foss., vol. iii (1843), p. 162, pl. K, figs. 1, 2.

[2] R. Owen, Odontography (1840), p. 57, pls. xviii, xix.

before or during fossilisation. One such specimen in the Brighton Museum has been described under the name of *Aulodus agassizi*.[1]

The vertebral centra have hitherto been found in direct association with the teeth of *Ptychodus* only in one specimen of *P. decurrens*, now in the British Museum (Pl. LII, fig. 6). They are biconcave discs of approximately circular shape, remarkable for their very short antero-posterior measurement. The crushed and broken example shown in Pl. LII, fig. 6, exhibits a fragment of the nearly

A

B

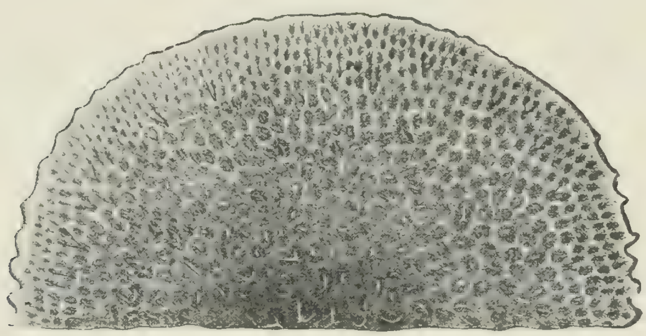


FIG. 72. *Ptychodus mammillaris*, Agassiz; vertical transverse section (A) and horizontal section (B) of tooth, highly magnified. After Agassiz.

smooth outer face of the primitive double-cone (*a.*), and also a portion of its inner layer (*b.*), which is marked by numerous fine radiating ridges. Within the double-cone the centrum is strengthened by closely arranged concentric laminæ (*c.*), which are so delicate that they are often distorted or even partially destroyed in the fossils (Pl. LII, fig. 16). These laminæ are pierced by a few rounded pores in irregular order, but they are never united by cross-bars. The thin middle part of the centrum is solid (seen in fig. 16, but broken away in fig. 6). Where each

[1] F. Dixon, Geol. Sussex (1850), p. 366, pl. xxxii, fig. 6. See also so-called "incipient teeth of *Ptychodus*," *op. cit.*, pl. xxx, figs. 4, 5.

pedicle of the neural and hæmal arches was attached, the concentric laminæ of the centrum are penetrated by a deep cavity (*d.*), which is filled by matrix in the fossils, but must have been occupied originally by uncalcified cartilage.

It is interesting to observe that nearly similar vertebral centra occur in the Lamnid shark, *Corax* (*supra*, p. 197), and one specimen has been referred to *Selache*,[1] which is the existing genus most closely related to *Corax*. It is, therefore, now uncertain whether the Selachian vertebræ from the Cretaceous of Antarctica which have been referred to *Ptychodus*,[2] really pertain to this genus.

Ptychodus is widely distributed in Upper Cretaceous formations in Europe and North America, but it appears and disappears suddenly in both regions. It begins with the low-crowned and simply ridged teeth of *P. decurrens*, which at first seem to represent a comparatively small variety; and it ends with teeth which are either very high-crowned (*P. rugosus*) or marked with gyrate ridges (*P. polygyrus*). Its predecessors have not hitherto been recognised, but the teeth

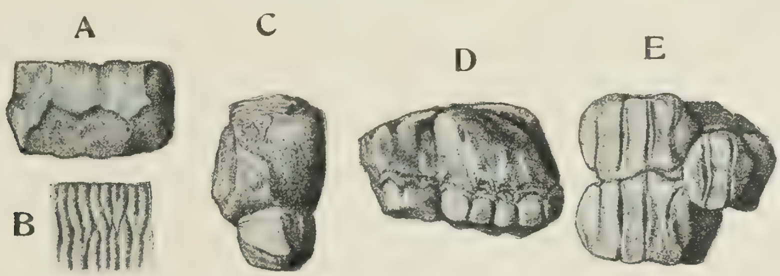


Fig. 73. *Apocopodon sericeus*, Cope; teeth of type specimen, nat. size.—Upper Cretaceous; Maria Farinha, State of Pernambuco, Brazil. A. Median tooth, coronal view, nat. size, with (B) part of its superficial gano-dentine, much magnified; C. side view of the same tooth; D. teeth of first and second inner paired rows, anterior view; E. same teeth, lower or attached surface.

of *Ptychodus* seem to be connected with those of the Tertiary Myliobatidæ by the dentition named *Apocopodon*, which occurs at the top of the Cretaceous series in South America.[3] In this genus (Text-fig. 73) the teeth are more or less distinctly quadrangular (A), with ends bevelled as irregularly as those of *Ptychodus*. The coronal surface is flattened and invested with a thin layer of gano-dentine, which is marked with fine antero-posteriorly-directed wrinkles (B). The root is sharply constricted from the crown (C), and differs from that of the teeth of *Ptychodus* in being very slightly marked on its lower face with a few shallow, broad, antero-posterior grooves (D, E), which become deeper and more numerous in

[1] *Selache davisi*, C. Hasse, "Einige seltene paläontologische Funde," Palæontogr., vol. xxxi (1884), p. 9, pl. ii, figs. 16, 17.

[2] A. S. Woodward, "On Fossil Fish-remains from Snow Hill and Seymour Islands," Wissensch. Ergeb. Schwed. Südpolar-Exped., 1901–03 (1908), vol. iii, pt. 4, with plate.

[3] E. D. Cope, "A Contribution to the Vertebrate Palæontology of Brazil," Proc. Amer. Phil. Soc., vol. xxiii (1886), p. 2.—A. S. Woodward, "Notes on Some Upper Cretaceous Fish-remains from Sergipe and Pernambuco, Brazil," Geol. Mag. [5], vol. iv (1907), p. 194, pl. vii, figs. 4, 5.

the typical Myliobatidæ of the Tertiary period. Flanking the median row there are at least three paired rows of teeth, which rapidly diminish in size outwards.

1. **Ptychodus mammillaris,** Agassiz. Plate XLVII, figs. 13—27; Text-figure 72.

1822. Teeth allied to *Diodon*, G. A. Mantell, Foss. S. Downs, p. 231, pl. xxxii, figs. 17, 18, 20, 21, 25, 27, 29.

1835–39. *Ptychodus mammillaris*, L. Agassiz, Poiss. Foss., Feuill., p. 54 (name only), and vol. iii, p. 151, pl. xxv*b*, figs. 12—20 (? fig. 11).

1835–39. *Ptychodus altior*, L. Agassiz, *op. cit.*, Feuill., p. 54 (name only), and vol. iii, p. 155, pl. xxv*b*, figs. 9, 10.

1839. *Ptychodus decurrens*, L. Agassiz (*errore*), *op. cit.*, vol. iii, p. 154, pl. xxv*b*, figs. 3, 5.

1850. *Ptychodus mammillaris*, F. Dixon, Geol. Sussex, p. 361, pl. xxx, fig. 6, pl. xxxi, fig. 4.

1850. *Ptychodus latissimus*, F. Dixon (*errore*), *op. cit.*, pl. xxxi, fig. 3.

1889. *Ptychodus mammillaris*, A. S. Woodward, Catal. Foss. Fishes B.M., pt. i, p. 133.

1890. *Ptychodus mammillaris*, A. S. Woodward, Ann. Rep. Yorks. Phil. Soc., 1889, p. 39, pl. i, figs. 3—14.

1911. *Ptychodus mammillaris*, G. E. Dibley, Quart. Journ. Geol. Soc., vol. lxvii, p. 271, pl. xxii, figs. 3—5.

Type.—Detached teeth; British Museum, and National Museum of Natural History, Paris.

Specific Characters.—The type species, of which the largest known teeth measure about 4·5 cm. in transverse diameter. Median portion of tooth much raised, and more or less sharply defined from the granulated marginal area; its upper surface flattened and crossed by regular, prominent, transverse ridges, which pass down the sides and are often continued gradually into the concentric lines of well-marked marginal granulations. Marginal area relatively wide, covered with granulations which are mostly elongated and arranged in lines concentric with the border of the crown; this area also often crossed by a few shallow radiating grooves.

Description of Specimens.—In the more typical teeth of this species the median raised portion gradually passes into the marginal area without any interposed groove, while its regular transverse ridges usually end in coarse tubercles which soon become finer and tend to be arranged in lines continuous with the concentric rows of granulations on the marginal area. The granulations are often so fine that they give the border of the tooth a silken aspect, and this is heightened by the shallow radiating grooves which cross it. Good illustrations of such teeth from a large specimen are given in Pl. XLVII, figs. 13—18. One tooth of this series (fig. 13) is evidently from the lower middle row, while another (fig. 14), showing especially well the passage of the median transverse ridges into the marginal granulation, probably represents the inner paired row of the upper jaw. The lateral teeth (figs. 15—18) are obliquely distorted, their middle portion is comparatively small and low, and the marginal area is widest on the outer side.

In another typical specimen, the teeth are considerably smaller and exhibit a more pronounced elevation of their median portion, at least in the upper jaw (Pl. XLVII, figs. 19, 20). A small tooth of the upper middle row (fig. 19, o') is nearly heart-shaped, and its conspicuous median raised portion, though now worn, must have been crossed originally by four or five well-marked ridges. A tooth which seems to be referable to the inner or second paired row of the upper jaw (fig. 20) is clearly unsymmetrical, and the outer paired teeth (fig. 19) show the usual oblique distortion and the predominance of the marginal area in their outer half. In other specimens the lateral extension or widening of the outer paired teeth is still more marked than in those now described.

In a few teeth with the marginal granulation still fine and typical, the median portion is less elevated and more coarsely ridged (Pl. XLVII, figs. 21, 22). This condition, however, is commoner in teeth with a coarsely granulated marginal area, which are known from several localities but cannot yet be recognised as characterising any particular zone. A tooth from Brighton figured by Dixon (*op. cit.*, pl. xxx, fig. 6) is normal in all respects except this coarseness of the surface-markings. In some associated teeth from the Mantell Collection (Pl. XLVII, figs. 23—27), the median raised portion is less elevated, and is marked off from the marginal area by a more or less well-defined groove.

In the teeth of *P. mammillaris* the transverse ridges are scarcely ever subdivided or irregular. One specimen in the Coombe Collection (B.M. no. P. 5391) exhibits a few tubercles intercalated between some of the ridges.

Horizons and Localities.—Turonian zones: near Lewes and Brighton, Sussex. Zone of *Rhynchonella cuvieri:* Burham, Kent; Betchworth and Dorking, Surrey; Culver Cliff, Isle of Wight; Pinhay Cliff, Dorset. Zone of *Terebratulina gracilis:* Halling, Kent. Zone of *Holaster planus:* Cuxton, Kent; Clothall, Hertfordshire; Luton, Bedfordshire; Culver Cliff, Isle of Wight; Heytesbury, Wiltshire. Zone of *Micraster cor-testudinarium:* Beer, Devon. Undetermined zones: Guildford, Surrey; West Harnham, Wiltshire.

2. **Ptychodus rugosus,** Dixon. Plate XLVIII, figs. 1—11.

1850. *Ptychodus rugosus,* F. Dixon, Geol. Sussex, p. 362, pl. xxxi, fig. 5.
1850. *Ptychodus altior,* F. Dixon (*errore*), *op. cit.*, p. 362, pl. xxx, fig. 10.
1889. *Ptychodus rugosus,* A. S. Woodward, Catal. Foss. Fishes B. M., pt. i, p. 136, pl. v, figs. 1—3.
1911. *Ptychodus rugosus,* G. E. Dibley, Quart. Journ. Geol. Soc., vol. lxvii, p. 272, pl. xxii, fig. 6.

Type.—Detached tooth.

Specific Characters.—Teeth as in *P. mammillaris*, but the summit usually more rounded, all the surface-markings less well-defined, and the transverse ridges more or less irregular or interrupted.

Description of Specimens.—The close resemblance of the ordinary teeth of this form to those of the type species is well illustrated by the associated series shown in Pl. XLVIII, figs. 1—5. These five specimens are from a group of about fifty teeth, all apparently belonging to the upper jaw. A median upper tooth (fig. 1) is remarkably smooth and very small. In the comparatively large teeth of the inner paired row (figs. 2, 3), two or three of the transverse ridges are uninterrupted, but they end suddenly, leaving the sides of the coronal eminence nearly smooth. There are slight traces of radiating grooves crossing the feebly-granulated marginal area. The lateral teeth (figs. 4, 5) exhibit the usual oblique distortion and relatively wide outer margin.

Some smaller teeth evidently belonging to the same species (figs. 6, 7) are characterised by an extremely elevated and laterally compressed central portion, of which the whole periphery is smooth. Those of the inner paired row also exhibit a comparatively narrow granulated marginal area. There are distinct gradations between these and the more normal teeth, and they may belong to immature individuals.

An apparently associated set of comparatively large teeth (figs. 8—11) may be regarded as representing a very old individual. In these teeth the median raised portion is much rounded, and the coarse though feeble surface-markings extend over its sides. Sometimes there is a slight constriction between the raised portion and the marginal area; while in one case (fig. 11) a curious malformation is observable.

Horizons and Localities.—Zone of *Micraster coranguinum:* Purley, Surrey; Charlton, Strood, Gillingham, Northfleet, and Greenhithe, Kent. Zone of *Micraster cor-testudinarium:* Croydon, Surrey. Undetermined zones: Guildford, Surrey; Houghton Pit, Arundel, Sussex; Dover, Kent.

3. **Ptychodus polygyrus**, Agassiz. Plate XLVIII, figs. 12—16; Plate XLIX.

1822. Teeth allied to *Diodon*, G. A. Mantell, Foss. S. Downs, p. 231, pl. xxxii, figs. 23, 24.

1835–39. *Ptychodus polygyrus*, L. Agassiz, Poiss. Foss., Feuill., p. 55 (name only), and vol. iii, p. 156, pl. xxv, figs. 4—11, pl. xxv*b*, figs. 21—23.

1837–43. *Ptychodus latissimus*, L. Agassiz (*errore*), *op. cit.*, vol. iii, p. 157, pl. xxv*a*, fig. 8.

1837. *Ptychodus polygyrus*, W. Buckland, Geol. and Mineral., ed. 2, vol. ii, p. 48, pl. xxvii*f*.

1850. *Ptychodus polygyrus*, F. Dixon, Geol. Sussex, p. 363, pl. xxx, fig. 9, pl. xxxi, fig. 10.

1850. *Ptychodus latissimus*, F. Dixon (*errore*), *op. cit.*, pl. xxx, figs. 1, 2.

1863. *Ptychodus polygyrus*, S. J. Mackie, Geologist, vol. vi, p. 161, pl. ix.

1887. *Ptychodus polygyrus*, A. S. Woodward, Quart. Journ. Geol. Soc., vol. xliii, p. 127, pl. x, fig. 11.

1889–90. *Ptychodus polygyrus*, A. S. Woodward, Catal. Foss. Fishes B. M., pt. i, p. 143 (*non* pl. v, fig. 7); and Ann. Rep. Yorks. Phil. Soc., 1889, p. 40, pl. i, figs. 15—20.

1908. *Ptychodus polygyrus*, G. Sheppard, Naturalist, p. 189, pl. xvi, fig. 14.

1911. *Ptychodus polygyrus*, G. E. Dibley, Quart. Journ. Geol. Soc., vol. lxvii, p. 268, pl. xxi, pl. xxii, figs. 1, 2, 9.

Type.—Detached teeth ; some in British Museum.

Specific Characters.—The largest known species, of which the lower median teeth sometimes measure 8 cm. in transverse diameter. Median portion of tooth not much raised, but flattened and crossed by coarse transverse ridges, which often curve round at the lateral ends and sometimes form loops. Marginal area of variable width, more or less coarsely granulated, often showing some concentric arrangement but never crossed by radiating grooves. Transverse ridges of lower median teeth from 11 to 14 in number.

Description of Specimens.—The teeth commonly referred to this species are so varied in shape and markings that it may be doubted whether they are rightly grouped together. Agassiz, indeed, originally recognised, besides the typical form, three varieties which he named *concentricus*, *sulcatus* and *marginalis* respectively. Of these, the single tooth figured as var. *concentricus* is most probably an abnormal example of *P. mammillaris*, while the two teeth named var. *sulcatus* seem to be referable to *P. decurrens*. Between the typical *P. polygyrus* and the variety *marginalis*, however, there appear to be all gradations ; and as the two forms have been proved by Mr. Dibley to occur in two successive horizons, it is probable that the one is a mutation of the other.

The typical form of *P. polygyrus* is found in the higher horizon, and is best known by an associated set of teeth discovered by Mr. W. Murton Holmes in the zone of *Micraster coranguinum* in Surrey. These teeth were scattered in a block of chalk, not arranged in natural order ; but the selection shown in Pl. XLIX probably illustrates the principal rows of both jaws correctly identified. The small upper median teeth (fig. 1, o′) are considerably longer than broad, with truncated anterior and posterior ends, and a remarkably deep root. Their coronal face is occupied chiefly by the finely granulated marginal area, the middle transversely-ridged portion, though variable, being always very small and not much raised. The transverse ridges are from four to six in number, and variously irregular or interrupted. The large upper teeth of the inner paired row (i′) agree closely in size, shape, and markings with the original typical teeth figured by Agassiz (*loc. cit.*, pl. xxv, figs. 10, 11, pl. xxv *b*, fig. 23). They bear nine or ten transverse ridges, which are more or less irregular, but always tend to converge in gyrations at the lateral borders. Their narrow granulated area is widest at the anterior and external margins. The teeth which seem to belong to the upper second paired row (ii′) are much smaller, and are crossed by seven to nine transverse ridges, which leave space for scarcely any granulation except at the anterior margin. The internal margin is sharply truncated, while the outer margin slopes gradually downwards to the plane of the next outer row. Some of these teeth exhibit a tendency to oblique distortion, which is still more marked in those of the next row (iii′). Here the teeth are much smaller, with only six or seven transverse ridges, but their internal margin is again more sharply

truncated than the outer margin. The large lower median teeth (fig. 2, O) correspond exactly with a tooth erroneously referred to *P. latissimus* by Agassiz (*loc. cit.*, pl. xxv *a*, fig. 8). Their median portion is gently raised (more elevated than in any of the other teeth), and crossed by eleven or twelve transverse ridges, which are often irregular, sometimes with intercalated tubercles, and always conspicuously gyrate at the ends. The marginal area is narrow, especially behind, and coarsely granulated. The teeth ascribed to the lower inner paired row (I) are rather larger than those of the upper second row (II′) and scarcely more sharply truncated at the internal than at the external margin. They are crossed by eight or nine transverse ridges, which tend to converge in the usual gyrations at the lateral borders, and leave very little space for marginal granulations except anteriorly. The teeth provisionally referred to the lower second paired row (II) are intermediate in size between those already described as belonging to the upper second and third paired rows, and are closely similar to the latter in shape. They bear seven or eight transverse ridges. The small lateral teeth of both jaws (fig. 3) are much wider than long, somewhat obliquely distorted, with from five to seven transverse ridges, which are usually regular and tend to converge at the ends. In most of these teeth the granulated marginal area is conspicuous.

Some of the teeth of the typical form of *P. polygyrus* are longer in proportion to their width than those just described, with one or two additional transverse ridges; and a few are less flattened. Through these every gradation appears to be traceable to the variety *marginalis*, which is smaller, and is sometimes not readily distinguishable from *P. mammillaris*. The type specimens of this variety are not accurately figured by Agassiz (*loc. cit.*, pl. xxv, figs. 6—8), and one of them, still in the Mantell Collection, is re-drawn in Pl. XLVIII, figs. 12, 12 *a*. This tooth evidently belongs to the first inner paired row, either upper or lower, and is peculiar in having the wide, flattened median area sharply raised above the marginal area. The marginal granulations are not coarse beads without order as shown by Agassiz; but those interno-laterally are arranged in concentric lines continuing the convergent transverse ridges, while those at the extreme border are much finer though also elongated in generally concentric lines.

The finest known associated set of teeth of the variety *marginalis* was discovered by Mr. G. E. Dibley in a Turonian zone at Wouldham, Kent, and a selection is shown, artificially arranged, but probably in natural order, in Pl. XLVIII, figs. 13, 14. Here the transverse ridges exhibit scarcely any irregularities, and their terminal gyration is well marked in the principal teeth. In the small upper median teeth (fig. 13, O′) the middle area is relatively larger and the anterior border more rounded than in the typical *P. polygyrus*. In the large upper teeth of the inner paired row (I′) the median portion is gently raised, though flattened; and it is crossed by eleven regular transverse ridges, of which the gyrate ends often pass into lines of granules on the marginal area. The teeth

ascribed to the upper second paired row (II′) are nearly similar, but smaller, with ten to twelve transverse ridges. The more lateral teeth (III′–VI′) begin to exhibit transverse elongation and slight oblique distortion, while their median portion is relatively smaller and their transverse ridges are less conspicuously gyrate at the ends. The large lower median teeth (fig. 14, O) are raised as in the typical *P. polygyrus*, but with more regularly gyrate transverse ridges, which are twelve to fourteen in number. The only teeth which seem referable to the lower inner paired row (I) are essentially similar to those of the upper second paired row; while those of the lower second paired row (II) are either a little wider or a little narrower than those of the third upper paired row.

A tooth wrongly ascribed to *P. latissimus* by Dixon (*op. cit.*, pl. xxx, fig. 2) is remarkable for the unusually great and sharp elevation of its median portion. It is crossed by nine transverse ridges and probably belongs to the inner paired row of either the upper or lower jaw. The same appearance of lateral compression, but with a more gently raised crown, is seen in the lower median teeth of an associated set which seems to be referable to var. *marginalis* (Pl. XLVIII, fig. 15). Each of these teeth is deeply impressed at the lateral border with smooth facettes for the adjacent teeth (fig. 15 *a*); and their gently rounded crown is crossed by about thirteen transverse ridges, which extend almost from edge to edge. The teeth of the inner paired row (fig. 16), either upper or lower, are flatter and crossed by eleven transverse ridges, which gyrate into the marginal granulation in the usual manner. The smaller lateral teeth do not exhibit any features worthy of note.

Horizons and Localities.—Turonian zones: near Lewes, Sussex; Wantage, Berkshire. Zone of *Rhynchonella cuvieri:* Dover and Dunton Green, Kent; Beachy Head, Sussex. Zone of *Terebratulina gracilis:* Halling, Blue Bell Hill, Wouldham, Charing, and Lenham, Kent. Zone of *Micraster cor-testudinarium:* Dover. Zone of *Micraster coranguinum:* Banstead and Croydon, Surrey; Grays, Essex; Charlton, Bromley, Northfleet, and Gravesend, Kent; Horsebridge and Micheldever, Hampshire; Amesbury, Wiltshire. Zone of *Actinocamax quadratus:* Salisbury. *Uintacrinus*-zone: Salisbury. Undetermined zones: Guildford; Winchester.

4. **Ptychodus latissimus**, Agassiz. Plate L; Text-figures 74, 75.

1811. Palate of Unknown Fish, J. Parkinson, Organic Remains, vol. iii, p. 262, pl. xix, fig. 18.

1822. Tooth allied to *Diodon*, G. A. Mantell, Foss. S. Downs, p. 231, pl. xxxii, fig. 19.

1835–43. *Ptychodus latissimus*, L. Agassiz, Poiss. Foss., Feuill., p. 54 (name only), and vol. iii, p. 157, pl. xxv *a*, figs. 1—7.

1839—40. *Ptychodus latissimus*, R. Owen, Rep. Brit. Assoc., 1838, p. 140; and Odontogr., descr. to pl. xvii, figs. 1, 2.

1850. *Ptychodus paucisulcatus*, F. Dixon, Geol. Sussex, p. 363, pl. xxx, fig. 3.

1873. *Ptychodus latissimus*, O. Rees, Proc. Geol. Assoc., vol. iii, p. 117.
1887–89. *Ptychodus latissimus*, A. S. Woodward, Quart. Journ. Geol. Soc., vol. xliii, p. 127, pl. x, fig. 12; and Catal. Foss. Fishes B. M., pt. i, p. 147.
1889. *Ptychodus polygyrus*, A. S. Woodward (*errore*), Catal. Foss. Fishes B. M., pt. i, pl. v, fig. 7.
1902. *Ptychodus latissimus*, M. Leriche, Ann. Soc. Géol. Nord, vol. xxxi, p. 91, pl. ii, figs. 1—7.
1906. *Ptychodus latissimus*, M. Leriche, Mém. Soc. Géol. Nord, vol. v, pp. 66, 73, pl. v.
1911. *Ptychodus latissimus*, G. E. Dibley, Quart. Journ. Geol. Soc., vol. lxvii, p. 270, pl. xx, figs. 3—5.
1911. *Ptychodus dixoni*, G. E. Dibley, *loc. cit.*, vol. lxvii, p. 270, pl. xx, figs. 1, 2.

Type.—Detached teeth; British Museum.

Specific Characters.—A large species, of which the lower median teeth sometimes measure 6 cm. in transverse diameter. Median portion of tooth flattened or gently raised and crossed by very coarse transverse ridges, with little or no

FIG. 74. *Ptychodus latissimus*, Agassiz; teeth of lower jaw, about one half nat. size.—Zone of *Terebratulina gracilis*; Condé (Nord), France. Geological Museum, University of Lille. After M. Leriche.

curvature at the lateral ends and never forming loops. Marginal area usually narrow, but often wide in the lower median teeth; more or less coarsely granulated, the granules sometimes in curved rows continuing the ends of the transverse ridges, but never crossed by radiating grooves. Transverse ridges of lower median teeth from 6 to 8 in number.

Description of Specimens.—The type specimens of this species in the Mantell Collection include three isolated lower median teeth, of which the least-coarsely marked is re-drawn in Pl. L, fig. 1. It is much wider than long, and its gently raised median portion is crossed by seven complete transverse ridges, of which the hinder three are sinuous in the middle and curve at their lateral ends into rows of granulations on the wide marginal area, while the anterior three ridges nearly converge into a gyration. The whole of the marginal granulation is coarse.

Another form of lower median tooth, with a narrow granulated marginal area and somewhat more marked gyration of the eight transverse ridges, has been wrongly referred to *P. polygyrus* (A. S. Woodward, *op. cit.*, 1889, pl. v, fig. 7). Except that it is a little wider in proportion to its length and sometimes has the hinder ridges more bent, this closely resembles the corresponding teeth in part of a lower dentition described by Leriche from the Turonian of France (Text-fig. 74). Similar lower median teeth also occur in an associated series in the Museum of Practical Geology from a Turonian zone at Wantage, Berkshire; and a larger specimen, with the ends of the seven transverse ridges less curved, is shown in Pl. L, fig. 4. Still another form of lower median tooth shown by Agassiz (*tom. cit.*, pl. xxv*a*, figs. 5, 6), and again in Pl. L, fig. 6, is crossed by only six very coarse ridges, of which the foremost or hindmost tends to be broken; and in this form the marginal area is sometimes as finely granulated as in *P. mammillaris* (Pl. L, fig. 5). The elevation of the middle portion in the latter tooth is unusually sharp.

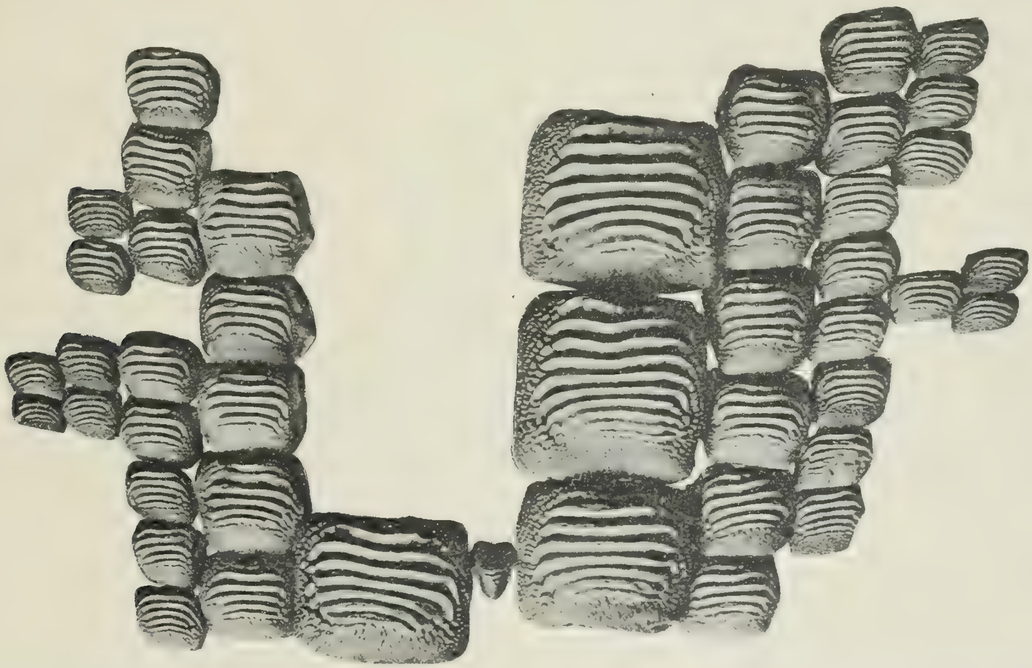


FIG. 75. *Ptychodus latissimus*, Agassiz; teeth of upper jaw, found associated with those shown in Text-fig. 74, about one half nat. size. After M. Leriche.

The teeth of the lower paired lateral rows are not satisfactorily known, but their arrangement is doubtless approximately correct in the original of Text-fig. 74, in a specimen described by Dibley (*loc. cit.*, 1911), and in the associated set from Wantage already mentioned in the Museum of Practical Geology. Some of these teeth also occur in association with the lower median tooth figured in Pl. L. fig. 1, and two are shown in figs. 2, 3. A tooth which seems to belong to the inner or first paired row (fig. 2) is slightly wider than long, and its total width equals about two thirds that of the median tooth. It is crossed by five complete ridges,

with a sixth beaded ridge behind, and all but the foremost curve forwards at the ends. As in the median tooth, its granulated margin is of considerable width. It is wider in proportion to its length than any of the three inner teeth shown in Text-fig. 74, though it agrees in relative size with the latter. The teeth regarded as belonging to the inner paired row in the Wantage specimen, however, are much smaller. An outer lateral tooth (fig. 3) exhibits oblique distortion, and is crossed by only five ridges. Other typical lateral teeth, either upper or lower, are figured by Agassiz, *tom. cit.*, pl. xxv *a*, figs. 1–4.

As shown by an associated set from Lewes in the Mantell Collection, the small upper median teeth are oblong in shape, with a truncated hinder border and a rounded anterior border (Pl. L, fig. 9). Their gently tumid coronal face is for the most part rugose or granulated, the raised portion being very small, confined to the middle of the anterior half and crossed by three or four coarse ridges. The posterior granulation forms faint ridges and grooves radiating from this raised portion to the truncated border. The teeth ascribed to the first or inner paired row are usually nearly square, and very variable in the coarseness and number of their transverse ridges. One small specimen (Pl. L, fig. 10) has the hinder three of its six transverse ridges sharply curved forwards at the ends. A larger specimen with only five transverse ridges (fig. 7) occurs associated with the coarsely-ridged lower median tooth shown in fig. 6. A shorter tooth of the same width as the latter, also with five transverse ridges, is the type specimen of the so-called *P. paucisulcatus*. Still larger teeth, probably of the same row, are sometimes very coarsely marked with only six transverse ridges (fig. 11), while others are more finely marked with nine or even ten ridges (fig. 12). The teeth of the other paired rows in the upper jaw are considerably smaller, and are not really distinguishable from those of the lower jaw. One found with the originals of figs. 6, 7, is shown in fig. 8.

The principal teeth of *P. latissimus* resemble those of other species in sometimes exhibiting considerable variations in their length compared with their width. This is especially well shown in the upper inner paired row of Text-fig. 75, where the shortest tooth is wider than long and only three quarters as long as the longest tooth. It is therefore justifiable to regard as belonging to a variety of this species the associated set of upper teeth, of which four are shown in Pl. L, figs. 13—16. The tooth of the inner paired row (fig. 13) is about two thirds as long as wide, and crossed by seven transverse ridges, of which the ends curve forwards in rows of granules over the narrow granulated area. Its determination as an upper inner tooth is confirmed by the presence of a well-marked facette of wear at one end, with no trace of wearing at the other end. The outer lateral teeth (figs. 14—16) progressively decrease in size and are crossed by six ridges.

Horizons and Localities.—Turonian zones: neighbourhood of Lewes and East-

bourne, Sussex; Wantage, Berkshire. Zone of *Terebratulina gracilis:* Cuxton, Kent; Whyteleafe, Surrey. Zone of *Holaster planus:* Blue Bell Hill, Burham, Kent; Luton, Bedfordshire; Heytesbury, Wiltshire. Zone of *Micraster coranguinum:* Gravesend, Kent; Grays, Essex; Brighton, Sussex; Brandon, Suffolk. Undetermined zones: Guildford and Croydon, Surrey; Hertford; Orford, Suffolk.

5. **Ptychodus decurrens**, Agassiz. Plates LI, LII; Text-figures 70, 71, 76, 77.

1752. *Dens piscis Ostracionis*, F. E. Brückmann, Acta Phys. Med., vol. ix, p. 116, pl. v, fig. 4.
1811. Palate of Unknown Fish, J. Parkinson, Organic Remains, vol. iii, pl. xviii, fig. 12.
1835–39. *Ptychodus decurrens*, L. Agassiz, Poiss. Foss., Feuill., p. 54 (name only), and vol. iii, p. 154, pl. xxv *b*, figs. 1, 2, 4, 6—8 (*non* figs. 3, 5).
1840–45. *Ptychodus decurrens*, R. Owen, Odontogr., vol. ii, pls. xviii, xix.
1850. *Ptychodus decurrens*, F. Dixon, Geol. Sussex, p. 362, pl. xxx, figs. 7, 8, pl. xxxi, fig. 1, pl. xxxii, fig. 5.
1850. *Ptychodus depressus*, F. Dixon, *op. cit.*, p. 363, pl. xxxi, fig. 9.
1850. *Ptychodus oweni*, F. Dixon, *op. cit.*, p. 364, pl. xxxi, fig. 2.
1887. *Ptychodus decurrens*, A. S. Woodward, Quart. Journ. Geol. Soc., vol. xliii, pp. 123—130, pl. x, figs. 1—10, 13.
1889. *Ptychodus decurrens*, A. S. Woodward, Catal. Foss. Fishes B. M., pt. i, p. 138.
1889. *Ptychodus oweni*, A. S. Woodward, *tom. cit.*, p. 138, pl. v, fig. 8.
1889. *Ptychodus multistriatus*, A. S. Woodward, *tom. cit.*, p. 146, pl. v, figs. 4—6.
1894. *Ptychodus levis*, A. S. Woodward, Proc. Geol. Assoc., vol. xiii, p. 192, pl. v, figs. 5, 6.
1904. *Ptychodus decurrens*, A. S. Woodward, Quart. Journ. Geol. Soc., vol. lx, p. 133, pl. xv.
1911. *Ptychodus decurrens*, G. E. Dibley, Quart. Journ. Geol. Soc., vol. lxvii, p. 264, pls. xvii—xix.

Type.—Detached teeth; one in British Museum.

Specific Characters.—A species usually of small or moderate size, but the lower median teeth occasionally measuring 6 cm. in transverse diameter. Median portion of tooth flattened or gently raised and crossed by numerous, regular, fine transverse ridges, which usually pass directly and merge into the finely-marked marginal area, but are occasionally recurved into loops in some of the principal teeth (var. *multistriatus*), and sometimes become irregular (var. *oweni*). Marginal area generally narrow, and its fine markings more or less radiating or directed at right-angles to the border, rarely in part concentric. Transverse ridges in lower median teeth from 10 to 16 (rarely more) in number.

Description of Specimens.—The type specimens are detached teeth from the English Chalk, of which only one (the original of Agassiz, pl. xxv *b*, fig. 8) can now be identified in the Mantell Collection. The species, however, is known by numerous groups of associated teeth, of which a few are arranged in the matrix in their natural order. These groups exhibit considerable variations not only in different parts of the mouth but also in different individuals; and some forms of the teeth appear to be worthy of varietal names.

The typical form of the dentition is shown of the natural size in Text-fig. 76,

which represents several teeth of both jaws cemented together in their natural position by iron pyrites. The rows of teeth of the upper jaw (marked I′ to III′) are exposed from their oral face, while some middle teeth of the lower jaw (marked O, I) are seen still in position opposed to them, and a few detached teeth are drawn separately. The upper median row of small teeth is nearly covered by pyrites, but one partially free example (O′) is shown in upper and anterior view. This tooth is tumid, longer than broad, and narrowed in front, its bluntly rounded anterior end fitting into the slightly hollowed posterior end of its predecessor. Its finely granulated marginal area is wider than in the other teeth, its few regular transverse ridges being confined to a small central portion. The teeth of the upper inner paired row (I′) are a little broader than long, with the crown raised into a gently arched dome. They are crossed by about ten regular transverse ridges, passing gradually at their ends into the narrow marginal area, in which the fine granulations distinctly tend to an arrangement in lines at right-angles to the margin. The teeth of the upper second paired row (II′) are scarcely more than half as broad as those of the first, while those of the third and fourth rows (III′, IV′) are still much smaller. The latter teeth are a little obliquely distorted, sometimes with an extension or expansion of the postero-internal angle. There were probably one or two more external rows, but these are not preserved. The lower dentition resembles the upper dentition in being marked with regular transverse ridges passing into radiating rows of marginal granulations; but the middle portion of the crown in all the teeth is more sharply raised than in those of the upper jaw. This elevation is specially marked in the symmetrical teeth of the lower median row (O), which are the largest teeth in the mouth and are crossed by about twelve transverse ridges. In the teeth of the lower inner paired row (I) the elevation is nearer to the outer than to the inner margin, and the whole crown is very unsymmetrical, often with the postero-internal angle irregularly produced. All these teeth are much broader than long, but those of the lower second paired row are more nearly equilateral, and their crown is both less elevated and less uniform in shape. The teeth of the more external lower rows are not identifiable. The average transverse measurements (in millimetres) of the teeth of the several rows are as follows: O′, 9; I′, 25; II′, 16; III′, 14; IV′, 10; O, 32 to 36; I, 26; II, 16.

The small specimen already described as showing the cartilage of the jaws (Text-fig. 70, p. 226) also displays teeth of the typical form of *P. decurrens*; but the relative proportions of the teeth of the several rows are somewhat different from those above mentioned, as indicated by the following average transverse measurements (in millimetres): O′, 4; I′, 6·5; II′, 5; III′, 4; IV′ 3·5; V′, 3; O, 8; I, 6·5; II, 5; III, 4; IV, 3; V, 2. This fossil may represent a young individual, but it is noteworthy that in the lowest zones of the Chalk some of the teeth are exceptionally small, smooth, and feebly marked. Such specimens (Pl. LI, figs. 13, 14) have been described under the name of *P. levis* (A. S. Woodward,

loc. cit., 1894), but, as suggested by Dibley (*loc. cit.*, 1911), they may best be regarded as representing a variety of *P. decurrens*.

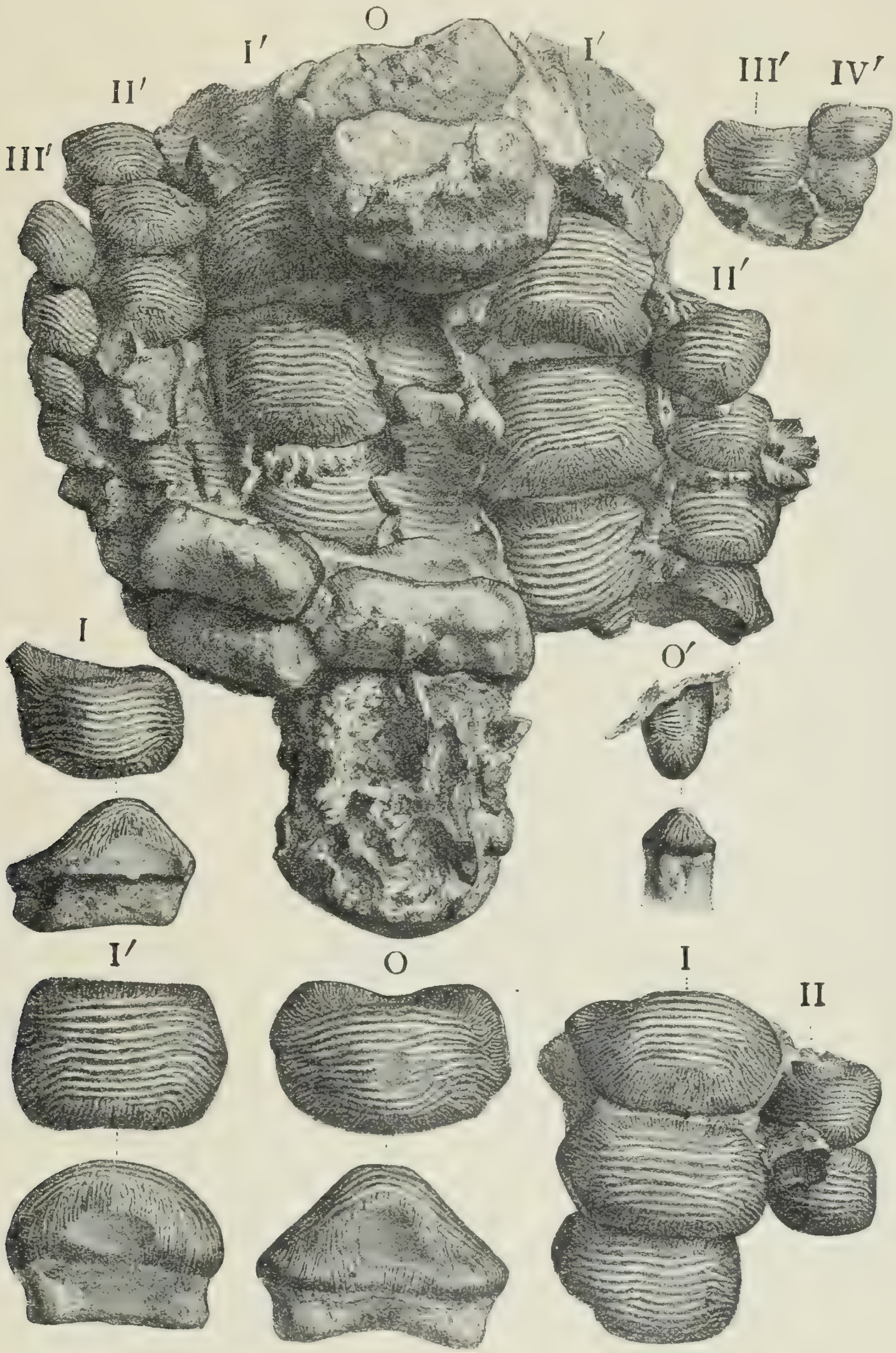


Fig. 76. *Ptychodus decurrens*, Agassiz; associated set of teeth of both jaws, mostly in original order, nat. size.—Chalk; near Brighton. Sussex. Willett Collection, Brighton Museum, no. 210A. O, Teeth of lower middle row; I, II, teeth of lower first and second paired rows; O′, tooth of upper middle row; I′–IV′, teeth of upper first to fourth paired rows. From Quart. Journ. Geol. Soc., vol. xliii (1887).

Other teeth with typical coronal markings, such as the lower median tooth shown in Pl. LI, fig. 7, have the marginal area relatively wide, especially in front.

Others, such as the tooth of the upper inner paired row shown in fig. 8, are remarkable for their large size and some irregularity.

A comparatively depressed and flattened tooth, apparently of the upper inner paired row, was named *P. depressus* by Dixon (*op. cit.*, 1850). Similar teeth occur in natural order in a portion of the upper dentition discovered by Mr. Dibley (Pl. LI, figs. 9–12), and they all exhibit the characteristic markings of *P. decurrens*, with a very narrow granulated marginal area, except in the small median teeth. The latter (fig. 10), which closely resemble the median tooth shown in Text-fig. 76, are partly obscured in the fossil by the squeezing together of the inner paired row (I′). The teeth of this row are slightly broader than long, and a detached example, drawn from several aspects in figs. 11–11*c*, shows all their characteristic features. Their transverse ridges are from nine to eleven in number, while those in the anterior half of each tooth curve forwards at the ends, which often diverge to admit short intercalated ridges. The teeth of the second paired row (II′) are similarly marked, but are much smaller and a little longer in proportion to their breadth. The smaller teeth of the third and fourth rows (III′, IV′) are also long in proportion to their breadth, but obliquely distorted. The average transverse measurements (in millimetres) of the teeth of the several rows are as follows: O′, 8; I′, 25; II′, 17; III′, 13; IV′, 11.

Part of a small lower dentition which seems to be referable to the depressed-toothed variety of *P. decurrens* is shown of the natural size in Text-fig. 77. The transverse ridges of the crown are fine and numerous, from 13 to 14 in number in the teeth of the middle row, and reaching the extreme margin, frequently with intercalations at the ends, in all the teeth. The average transverse measurements (in millimetres) of the several rows preserved are as follows:—O, 21; I, 14; II, 10; III, 9.

The irregularities observable in the arrangement of the transverse ridges of the teeth just described are still more conspicuous in some other teeth of the depressed variety. Five such specimens from an associated set are shown in Pl. LII, figs. 1–5, and appear to be referable chiefly to the upper jaw. In a tooth of the inner paired row (fig. 2), the anterior ridges begin to be irregularly branched, with two or three intercalated tubercles. In the teeth apparently of the upper second and lower first paired rows (figs. 3, 1) the ridges are more regular, but in those perhaps of the upper third paired row (fig. 4) and outer rows (fig. 5) they are very irregular, again with intercalated tubercles. Vermiculating ridges and more numerous intercalated tubercles are also seen in the two small associated teeth represented in Pl. LII, figs. 7, 8; and the extreme of this type of irregularity is reached in the larger teeth which have received the name of *P. oweni* (Dixon, *op. cit.*, 1850). Dixon's type specimen seems to belong to the upper inner paired row, and two other teeth of the same row, which were probably found with it, are shown in Pl. LII, figs. 9, 10. Here there is scarcely

a continuous transverse ridge; but in a lower median tooth (fig. 11), evidently of the same set, a few of the regular transverse ridges are again distinct.

Of the typically marked teeth of *P. decurrens* there are thus three varieties, namely: (1) diminutive smooth teeth, to be known as var. *levis*; (2) depressed teeth with more or less regular transverse ridges, to be named var. *depressus*; and (3) depressed teeth with very irregular transverse ridges, to be named var. *oweni*. It only remains to add that there is still a fourth variety in which the transverse ridges are more or less recurved into loops at the ends.

Teeth of this form exhibit sometimes a normally raised, sometimes a depressed

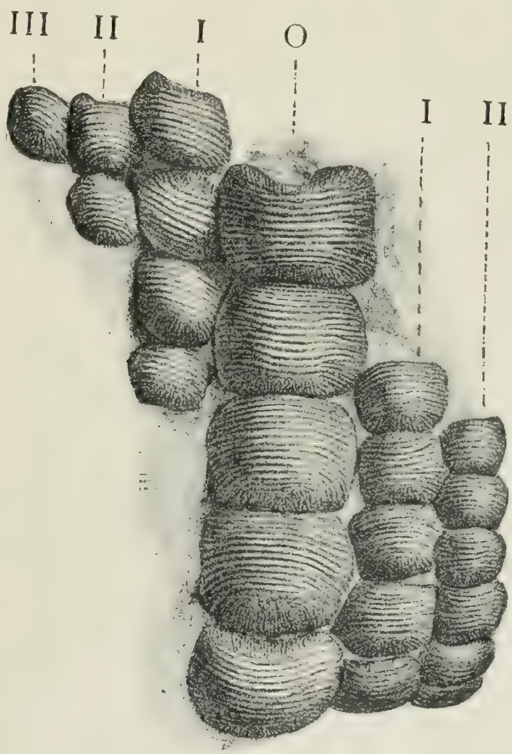


Fig. 77. *Ptychodus decurrens*, Agassiz; teeth of lower jaw in original order, nat. size.—Chalk; Kent. B. M. no. 40056.

crown, and there is every gradation between the tapering ends and the complete loops of the transverse ridges. The well-preserved portion of upper dentition shown in Pl. LI, figs. 4–6, indeed, exhibits teeth with transverse ridges which end in concentric loops at the outer border while tapering in the normal manner at the inner border. In the small median teeth (o′) the central area is much raised and the ridges are directly transverse, without curvature at the ends (fig. 5). In the inner paired series (i′) the crown of each tooth is considerably raised, and the concentric looping of the ten transverse ridges at the outer border is especially conspicuous, while their tapering inner ends are merely inclined forwards. The granulated marginal area is very narrow, and is almost lacking at the lateral borders of the teeth in the more external rows, which are low and more or less

obliquely distorted. The average transverse measurements (in millimetres) of the several rows preserved are as follows: o′, 7; i′, 17; ii′, 12; iii′, 9; iv′, 7.

In another set of scattered but associated teeth a lower median tooth is normal (Pl. LI, fig. 3), while the lateral teeth (figs. 1, 2) exhibit more or less distinct gyrations surrounded by an area of granulations which form concentric rather than radiating lines. In a third set discovered and described by Mr. Dibley (*loc. cit.*, 1911), the ridges on the lower median teeth are partly gyrate, partly irregular (Pl. LII, figs. 12, 13), while those of the lower paired rows are normal (fig. 14), and a tooth of the upper inner paired row (fig. 15) begins to make some approach to the corresponding tooth of var. *oweni*.

The extreme gyration of the transverse ridges occurs in the depressed teeth which have been described under the name of *P. multistriatus* (A. S. Woodward, *loc. cit.*, 1889). A lower median tooth of the type set, which shows well-marked gyrations in its hinder half, is crossed by no less than 20 ridges. In an associated short and broad tooth the ridges are nearly normal, while in a smaller lateral tooth gyrations are again conspicuous. Another tooth of the same set, which seems to belong to the upper jaw, exhibits a gyration anteriorly.

P. decurrens is the only species of which teeth have been found in the English Chalk in their natural order. It is also the only species of which the jaw-cartilages and vertebral centra have been discovered in association with the teeth. These skeletal parts have already been described above, pp. 226, 228.

Horizons and Localities.—Turonian zones: neighbourhood of Lewes and Brighton, Sussex. Zone of *Holaster subglobosus:* Halling, Holborough, Wouldham, Blue Bell Hill, and Dover, Kent; Oxted, Merstham, and Dorking, Surrey; Tring, Hertfordshire; Cherry Hinton, Cambridgeshire; Whittington, Norfolk; Winchester. Zone of *Rhynchonella cuvieri:* Betchworth, Surrey. Zone of *Holaster planus:* Swaffham, Norfolk. Undetermined zone: Guildford, Surrey.

6. **Ptychodus** aff. **mortoni**, Mantell. Pl. LIV, fig. 1.

(?) 1850. *Ptychodus mortoni,* F. Dixon, Geol. Sussex, p. 364, pl. xxxi, figs. 6, 7.
1894. *Ptychodus mortoni,* A. S. Woodward, Proc. Geol. Assoc., vol. xiii, p. 191, pl. v, fig. 4.
1911. *Ptychodus mortoni,* G. E. Dibley, Quart. Journ. Geol. Soc., vol. lxvii, p. 272, pl. xxii, fig. 8.

Type (of *Ptychodus mortoni,* Mantell, in S. G. Morton, Journ. Acad. Nat. Sci. Philad., vol. viii, 1842, p. 215, pl. xi, fig. 7).—Detached tooth from the Upper Cretaceous of Alabama, U.S.A.; British Museum.

Description of Specimen.—A tooth from the Chalk of Shoreham, which appears to have been lost, was referred to *P. mortoni* by Dixon, *op. cit.*, but his determination is doubtful. The only other known specimen from the English Chalk which nearly resembles the teeth of the American species, is shown of the natural size from the upper and anterior aspects in Pl. LIV, figs. 1, 1*a*. It is merely the

middle raised portion of a dental crown, and was obtained from an undetermined horizon near Winchester. It rises to an obtusely pointed apex, from which two antero-posterior, and two lateral ridges radiate at right angles to each other. Small irregular branches from these ridges, with other intercalated branching ridges, fill the sectors between them. All these ridges end below in vermiculations, which gradually pass into the fine granulation of the marginal area, of which only a fragment is seen in the fossil. So far as preserved, therefore, the specimen cannot be distinguished from a tooth of *P. mortoni*, but its specific determination must remain provisional until complete teeth of the same form are discovered.

P. mortoni has been regarded as the type of a sub-genus, *Hemiptychodus*, by Jaekel[1]; but the discovery of the nearly complete dentition of this species in the Chalk of Kansas,[2] and the frequent tendency to radiation of the tooth-ridges in *P. decurrens*, suggest that such complication of nomenclature is hardly necessary.

SUPPLEMENT.

Berycopsis elegans, Dixon (p. 5) Plate LIII, fig. 1.

The new specimen shown of two thirds the natural size in Pl. LIII, fig. 1, is interesting as exhibiting the shape and proportions of the caudal region. It was obtained by Mr. W. E. Balston from the zone of *Holaster subglobosus* at Halling, Kent, and was presented by him to the British Museum. The head is displaced forwards and upwards, while the greater part of the jaws and the opercular bones are wanting. The anterior region of the trunk is somewhat depressed by crushing, as shown by the displacement of the scales; and its ventral portion is partly destroyed. The tail, however, seems to exhibit very little distortion. It is thus clear that the caudal region between the dorsal and anal fins is less tapering than it is represented to be in the restored figure of the species on p. 7 (Text-fig. 2); that it is, in fact, shaped as in *Platycormus germanus*, from the Senonian of Westphalia. The narrow caudal pedicle is also longer than it was supposed to be. The well-preserved squamation extends over the bases of the dorsal and anal fins, as already observed in other specimens; and it is also seen to pass gradually into small scales which cover the basal part of the caudal fin. The caudal fin-rays are much broken and their distal portions are destroyed. Only parts of the anterior spines and the undivided proximal ends of the other rays of the dorsal and anal fins are preserved, so that the shape of these fins still remains unknown.

[1] O. Jaekel, Die eocänen Selachier vom Monte Bolca (1894), p. 137.

[2] S. W. Williston, "Cretaceous Fishes," Univ. Geol. Surv. Kansas, vol. vi (1900), p. 238, pls. xxv–xxvii.

Hoplopteryx, Agassiz (p. 13).

In Ann. Mag. Nat. Hist. [8] vol. vii (1911), p. 5, pl. i, Mr. C. Tate Regan has pointed out that three known species of Berycoids existing in the seas off South Australia and New Zealand are referable to *Hoplopteryx.* He publishes a figure of the Australian *H. affinis.*

Hoplopteryx superbus (Dixon) (p. 20).

The group of specimens in a block of chalk shown in Pl. V is noticed and figured in a newspaper, "The Illustrated Times," 24th November, 1855, p. 405. It is stated to have been obtained from the neighbourhood of Rochester, Kent.

Hoplopteryx simus, A. S. Woodward (p. 23).

Dr. Arthur W. Rowe has obtained a specimen of this species from the base of the zone of *Micraster cor-testudinarium* at Dover.

Apateodus striatus, A. S. Woodward (p. 38). Plate LIV, fig. 4.

A nearly complete large skull and mandible of this species, recently acquired by the Museum of Practical Geology, confirms the published description in several respects and makes some additions to our knowledge of the osteology of *Apateodus.* The occipital region of the cranium, especially, is more clearly shown han in the specimens previously studied. The greater portion of the cranial roof (Pl. LIV, fig. 4*a*) is formed by the frontal bones (*fr.*), which expand above the orbits into large supraorbital flanges, and taper forwards to overlap, in an uncertain degree, the attenuated and bluntly pointed mesethmoid (*eth.*). They are without ornament even on their radiating ridges. Behind the left frontal, the small parietal (*pa.*) is sufficiently well preserved to show that it meets its fellow in the median line in a wavy suture; and this pair of bones is clearly crossed at the hinder margin by a transverse slime-canal. Posterior to the parietals the occipital border evidently consists of the supraoccipital bone (*socc.*) flanked by the pair of epiotics (*epo.*), and must have been covered by a forward extension of the body-muscles. The supraoccipital bears a large posterior crest, which does not rise above the plane of the flattened cranial roof; but its anterior portion does not appear to extend forwards beneath the parietals to the frontals, and it seems likely that the bone interpreted as supraoccipital in the small skull already described (p. 39, Pl. XI, fig. 1*b*) is really the left parietal displaced by crushing. A fragment of the ossified sclerotic (Pl. LIV, fig. 4, *scl.*) is seen in the orbit;

while of the jaws the characteristic palatopterygoid and mandible are shown, lacking the maxillary arcade. The hinder part of the cheek is completely covered by three large postorbital plates (*po.*), which are smooth and only marked by the usual slime-canal near their anterior margin. Beneath the orbit there is a long and narrow suborbital (*so.*), which is much attenuated forwards. The slime-canal traversing it gives rise to a few branches which are inclined downwards and backwards. The antorbital cheek-plate (*ao.*) is also low and elongated, its hinder end being produced into a very long extension beneath the suborbital. It is smooth and only marked by its conspicuous slime-canal. A long and narrow supraorbital plate is seen above the anterior half of the orbit on the right side of the specimen. The opercular bones are not well preserved; but the preoperculum is shown on the right side to be marked by a few coarse radiating ridges on its expanded angle, while the suboperculum (*sop.*) on both sides is proved to have been comparatively large. There appears to be also a small separate interoperculum (*iop.*).

A side-view of the skull, opercular bones, and pectoral arch of an allied existing genus, *Alepidosaurus*, has been published by C. Tate Regan, Ann. Mag. Nat. Hist. [8] vol. vii (1911), p. 131, fig. 6.

Ctenothrissa radians (Agassiz) (p. 78).

Dr. Malcolm Burr has obtained a specimen of this species from the middle of the zone of *Rhynchonella cuvieri* at Guilford Colliery, Kent.

Aulolepis typus, Agassiz (p. 85). Plate LIII, fig. 2.

The nearly complete fish shown of the natural size in Pl. LIII, fig. 2, displays a large part of the dorsal and anal fins, and is also interesting in other respects. The typical jaws are seen, but the maxilla is broken across and its hinder portion is displaced. Thin smooth scales occur on the cheek, but in addition to the large antorbital plate already seen in other specimens, there are long and narrow plates of the circumorbital ring posteriorly, each traversed by the deep groove of the slime-canal. The operculum, which exhibits traces of at least a partial covering of thin smooth scales, is narrowed above, and the length of its anterior margin is nearly twice as great as its maximum width. The suboperculum is elongate-triangular in shape, while the interoperculum is relatively large and extended. All these bones are smooth. In the pectoral arch the small elongate-triangular post-clavicle is distinctly overlapped by the widest part of the clavicle. The pelvic fins (*plv.*) are well shown, each with about nine rays, which are all articulated distally for somewhat less than half of their length. The dorsal fin (*do.*), though

imperfect, is seen to occupy about half the length of the back of the trunk, and its anterior rays are very long and stout, the length of the longest considerably exceeding the depth of the trunk at its insertion. All the rays preserved have a long undivided basal portion, above which they are crossed by well-spaced articulations. Their total number cannot be ascertained, on account of the destruction of the middle of the fin. The anal fin (*a.*) arises opposite the hinder termination of the dorsal fin, and, so far as preserved, exhibits ten or eleven slender rays, which are divided and crossed by well-spaced articulations in their distal portion for more than half their length. The caudal fin (*c.*) is fragmentary, but its rays are comparatively stout. The characteristic smooth ridge which marks the course of the lateral line is conspicuous along the whole length of the trunk.

Portheus sp. (p. 102). Text-figure 78.

The shape of the maxilla in the type species of *Portheus* is known to have been so variable,[1] that the specific determination of detached examples of this bone proves to be uncertain. The fine large specimen shown of one half the natural size in Text-fig. 78 cannot, therefore, receive a definite name, though it probably belongs to the same species as the fragments of a large fish provisionally referred to *P. mantelli* on p. 102. The oral border of this new specimen is sufficiently well preserved to show that it is much less arched than in the typical maxilla of *P. mantelli*. Its upper border is also evidently straighter; but its posterior end is broken both above and behind, so that this part does not admit of comparison. Several of the smooth teeth are seen, and those in the deep anterior third of the bone are especially large. The outer face of the bone, where well preserved, is nearly smooth.

Portheus sp. (p. 103). Text-figure 79.

The imperfect mandible shown of two thirds the natural size in Text-fig. 79, is peculiar on account of the regular concavity of its oral border and the sharp angulation of its symphysial end. The outer face of the anterior part of the dentary (*d.*) is smooth and gently convex; and its symphysial border slopes rapidly downwards and backwards. The bone ends behind in a slight coronoid process, and the posterior quarter of the ramus is formed by the relatively small articulo-angular element (*ag.*), which is produced forwards as a tapering plate beneath the posterior half of the dentary. The teeth are narrow, high, and

[1] A. Stewart, "Teleosts of the Upper Cretaceous," Univ. Geol. Surv. Kansas, vol. vi, Paleont., pt. ii, 1900, p. 269, pls. xxxvii—xxxix.

straight, largest in the anterior third, and smallest in the middle of the dentary border.

The shape of the dentary readily distinguishes this mandible from that of

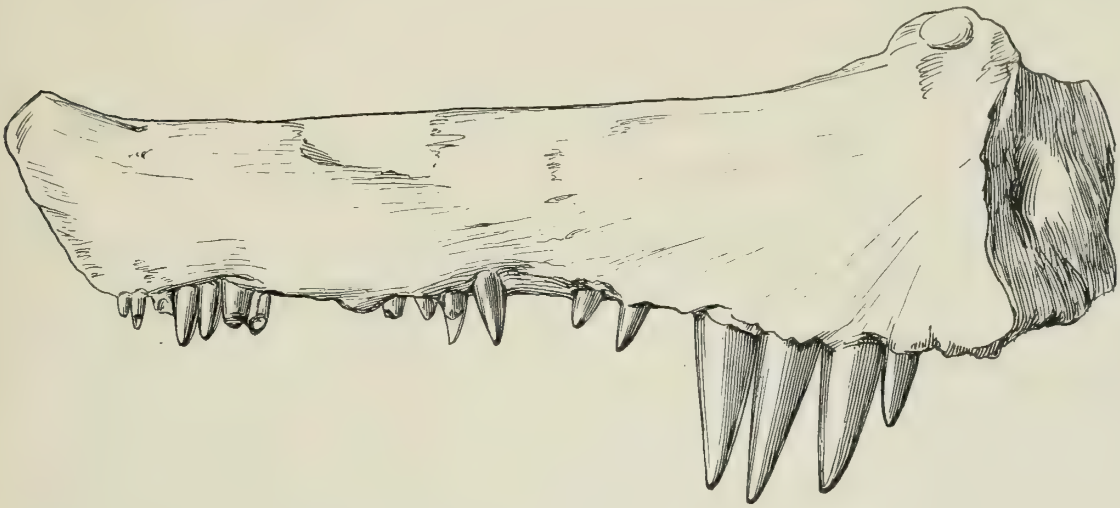


FIG. 78. *Portheus* sp.; right maxilla, outer view, one half nat. size.—Zone of *Holaster subglobosus;* Dover. B. M. no. P. 10813.

P. gaultinus, and also seems to separate it specifically from the other known mandibles of *Portheus*. It may perhaps prove to be the mandible of *P. daviesi*, though the teeth are relatively high and narrow.

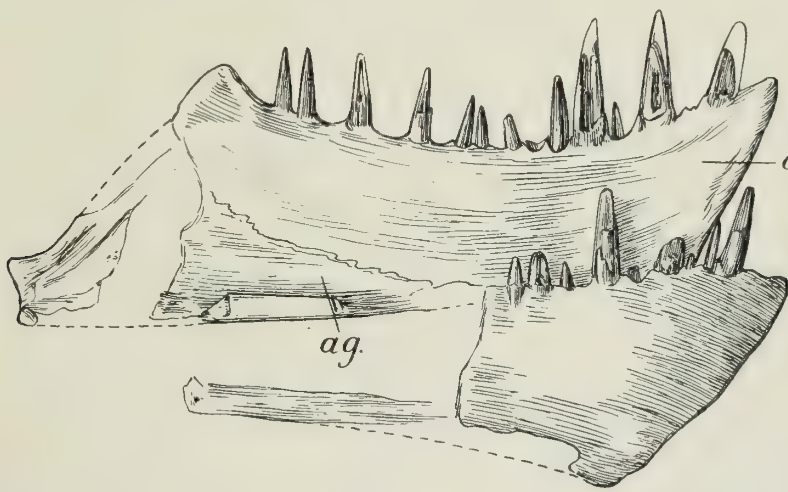


FIG. 79. *Portheus*, sp.; imperfect mandible, two thirds nat. size.—Zone of *Holaster subglobosus;* Cherry Hinton, Cambridgeshire. B. M. no. P. 10731. *ag.*, articulo-angular; *d.*, dentary.

Pachyrhizodus sp. (p. 132). Plate LIV, fig. 2.

Part of a small head of *Pachyrhizodus* discovered by Mr. Henry C. Drake, F.G.S., in the zone of *Holaster subglobosus* at South Ferriby, Lincolnshire, is interesting on account of the deepened shape of its premaxilla and the feebleness of its dentition. It displays the lower part of the left side, and is shown of the

natural size in Pl. LIV, fig. 2. Part of a postorbital cheek-plate (*po.*) is very thin and smooth, marked only by the circumorbital slime-canal and its few radiating branches. The large fan-shaped quadrate (*qu.*) is exposed beneath, in direct articulation with the mandible. The premaxilla (*pmx.*) is small, short, and deep; and in front end-view its oral thickening seems to bear the broken hollow base of one or perhaps two relatively large inner teeth. The length of the maxilla (*mx.*) equals about six times its maximum depth; its oral border is nearly straight, but the hinder half of the bone tapers a little to the rounded end. In the mandible, the articulo-angular is produced into a thick upturned postarticular process, and the outer face is longitudinally ridged. The dentary (*d.*) exhibits the characteristic smooth longitudinal bulging of the outer face and the thickening of the tapering symphysis. The teeth are comparatively small, with smooth curved crowns, those of the front of the mandible not much larger than those of the premaxilla. The lower end of the preoperculum (*pop.*) is much expanded and marked by radiating grooves. The interoperculum (*iop.*) is equally wide, nearly four times as wide as deep, and marked with fine downwardly-directed grooves. The upper branchiostegal rays (*br.*) are comparatively wide, but gradually pass downwards into narrow rays supported by the ceratohyal.

Two of the anterior vertebral centra are shown to be shorter than deep, and the scales resemble those of *Pachyrhizodus subulidens.*

This fossil is distinguished from the corresponding part of *P. subulidens* by the shape of the maxilla and apparently by the relatively smaller size of the mandibular teeth; but it evidently represents a closely allied species.

Elopine or **Albulid.** Plate LIV, fig. 3.

The imperfect ovoid dental plate shown of the natural size in Pl. LIV, fig. 3, appears to belong to the parasphenoid of some Elopine or Albulid fish not hitherto found in the Chalk. The bone, which is of loose texture, is a flat plate, easily distinguished from the vomer of a Pycnodont. Its oral face is irregularly undulating, and is completely covered with stout, bluntly-conical or rounded teeth, which are very variable in size and have no regular arrangement. The teeth are covered with dull ganoine, and most of them are of the blunt shape shown in the enlarged drawing, fig. 3*a*; but some, which appear to be unworn, exhibit a minute tubercle or point at the summit of the crown. They are hollow, with a large pulp cavity, and there are no traces of successional teeth.

A dentition very similar to that of the parasphenoid in the existing *Albula*, has already been found in the Cenomanian of France (*Pisodus foucardi*, H. E. Sauvage, Bull. Soc. Sci. Nat. Yonne, vol. xxxiii, pt. ii, 1879, p. 50, pl. i, fig. 2), perhaps also in the Upper Cretaceous of southern Italy (*Glossodus heckeli*, O. G. Costa, Atti Accad. Pontan., vol. viii, 1864, p. 109, pl. ix, figs. 12, 13). The teeth in *Albula*,

however, and apparently in these fossils, are less elevated and more brightly enamelled than those of the new specimen now described. In shape the new teeth agree more closely with those observed within the mouth of the Gonorhynchid, *Charitosomus major*, from the Upper Cretaceous of Mount Lebanon (A. S. Woodward, Catal. Foss. Fishes Brit. Mus., pt. iv, 1901, p. 273, pl. xv, fig. 3).

Protosphyræna, Leidy (p. 145).

Part of a notochordal tail, certainly of this genus, from the Chalk of Kansas, U.S.A., has been described and figured by C. E. McClung, Kansas Univ. Science Bull., vol. iv (1908), p. 245, pl. xiii.

Protosphyræna stebbingi, A. S. Woodward (p. 153).

Mr. Thomas Sheppard has obtained for the Hull Museum a large part of the rostrum of this species from the zone of *Holaster subglobosus* at South Ferriby, Lincolnshire. The new specimen, showing part of the rostrum which is missing between the two fragments of the type specimen, curves slightly upwards in front. All the ridges on its upper face are more or less tuberculated. A description and figure will appear in The Naturalist.

Gyrodus (?) cretaceus, Agassiz (p. 167). Plate LIV, fig. 5.

The nearly complete lower dentition of this species, discovered by Mr. George Hutchings, is shown of the natural size in Pl. LIV, fig. 5. It is proved to cover the splenial element on each side to its outer margin, and the bone is seen to rise into a small coronoid elevation behind. The teeth are crowded and remarkably irregular in size, arrangement, and amount of wearing; but the principal longitudinal row of comparatively large teeth is distinguishable, and a regular marginal series in front seems to belong to the dentary bones. The supposed dentary teeth, of which four occur on the right side of the fossil, are round and considerably elevated, each in the form of a blunt cone with a wide cingulum encircling its base (fig. 5*d*). A similar dental crown was obtained by Mr. F. Harford from a Turonian zone at Upper Halling, Kent (B.M. no. P. 5617). The teeth of the principal longitudinal row on the splenial are very variable in size and shape, but most of them are slightly longer than broad, with a bluntly conical crown passing down into a wide basal cingulum (fig. 5*c*); only a few of the hinder teeth exhibit the lateral compression and forward displacement of the coronal apex already described in the fragment shown in Pl. XXXV, fig. 6. The irregular manner in which they are worn by the opposing teeth is curious. Most

of the marginal teeth of the splenial resemble those ascribed to the dentary, though their central cone is relatively smaller and less elevated; but a few of these teeth just within the coronoid elevation tend to lose the cingulum on the outer face (fig. 5*b*), and extend downwards and forwards on their inner face, while their apex is inclined forwards (fig. 5*a*). The small intermediate teeth are especially irregular, largest and most distinctly ovoid along the inner margin of the splenial, most definitely mammillated in the two rows external to the principal row.

Acrotemnus faba, Agassiz (p. 169).

An associated set of teeth of an allied species, *A. splendens*, from the Upper Senonian of Harmignies, near Mons, Belgium, has been described by M. Leriche, Bull. Soc. Belge Géol., vol. xxv (1911), Proc. Verb., p. 162, pl. A. The anterior teeth are hooked and prehensile, resembling the specimen shown in Pl. XXXV, fig. 8.

The Jurassic Pycnodont teeth most closely similar to the molars of *Acrotemnus* are those of *Mesturus* (A. S. Woodward, Ann. Mag. Nat. Hist. [6], vol. xvii, 1896, p. 1, pls. i—iii).

Notidanus pectinatus, Agassiz.

1843. *Notidanus pectinatus*, L. Agassiz, Poiss. Foss., vol. iii, p. 221, pl. xxxvi, fig. 3.

This name was given to a tooth, originally in the Mantell Collection, which differed from *N. microdon* (see p. 222) in having distinct denticles instead of mere serrations at the base of the principal cusp anteriorly. No other specimen has been discovered.

SUMMARY AND CONCLUSION.

So large a proportion of the fishes from the English Chalk are still known only by fragments that this Monograph is necessarily disappointing. It is merely a pioneer work, which shows how much remains to be discovered concerning even some of the commonest fossils. It is, however, interesting in at least three respects, and leads to results which are not without value. The detailed descriptions of the cranial osteology of the bony fishes indicate closer resemblances between the Cretaceous genera and their existing representatives than have hitherto been suspected. The highly specialised skull of *Hoplopteryx*, for example, is shown to have remained unchanged from the Cretaceous period to the present day. At the

same time, it appears that certain Cretaceous genera are distinctly synthetic types, combining features which are characteristic even of separate families in the existing fauna. The skull of *Ichthyodectes*, for example, is mainly similar to that of the surviving *Chirocentrus*, which belongs to the same or a closely-related family; but it differs in exhibiting a pit in the side of the otic region, which is now found, not in the Chirocentridæ, but in the Elopidæ and Clupeidæ. Finally, although some of the Cretaceous fishes are survivors of groups which particularly characterise the Jurassic period, these later forms are proved to be more highly specialised, and most of them are easily distinguished from their predecessors.

The highest types represented, although Acanthopterygians, belong only to families of Berycoids and generalised Scombroids, which are always placed lowest in the spiny-finned series; but it must be remembered that the English Chalk fails to provide any record of the latest phase of the Cretaceous period. The Danian deposits of Southern Scandinavia, which are referable to this phase, just before the beginning of the Tertiary, yield Acanthopterygians of the same groups,[1] but one of them, *Bathysoma lutkeni*, is very curiously specialised. The Danian of Persia furnishes numerous imperfect specimens, which have been provisionally interpreted as Cottoids, Gobioids, and Blennioids,[2] but they are so much crushed in fissile limestone that their precise determination is impossible. The still later Montian Chalk of northern France[3] and the Lameta Beds of India[4] seem to contain true Percoids; and there is a very late Cretaceous fish-bearing deposit in northern Brazil[5] which may yield interesting material when exhaustively explored. None of the Acanthopterygian fishes, however, hitherto obtained from these uppermost Cretaceous formations reveal the initial stages in the differentiation of the modern specialised groups, which appeared in the Lower Eocene and were as well defined in the Upper Eocene as they are at the present day. These ancestral types still remain to be discovered.

The generalised Acanthopterygians, which are best known from the English Chalk and from the Upper Senonian of the Lebanon and Westphalia, evidently originated at the beginning of the Cretaceous period; for both *Aipichthys* and a true Berycoid have been found at the base of the Cenomanian in Austria.[6] They are

1 J. W. Davis, "On the Fossil Fish of the Cretaceous Formations of Scandinavia," Trans. Roy. Dublin Soc. [2], vol. iv (1890), pp. 417—427, pls. xliii–xlvi.

2 F. Priem, "Poissons Fossiles de Perse," Mission de Morgan (Paris, 1908), pp. 15—18, pl. ii, fig. 9. pl. iii, figs. 2–11.

3 F. Priem, "Sur la Faune Ichthyologique des Assises Montiennes du Bassin de Paris," Bull. Soc. Géol. France [3], vol. xxvi (1898), pp. 399—412, pls. x, xi.

4 A. S. Woodward, "On some Fish-remains from the Lameta Beds at Dongargaon, Central Provinces," Pal. Indica, N.S., vol. iii, No. 3 (1908).

5 A. S. Woodward, "Notes on some Upper Cretaceous Fish-remains from the Provinces of Sergipe and Pernambuco, Brazil," Geol. Mag. [5], vol. iv (1907), pp. 193—197, pl. vii.

6 F. Bassani, "Descrizione dei Pesci Fossili di Lesina, etc.," Denkschr. math.-naturw. Cl. k. Akad. Wiss. Wien, vol. xlv (1882), p. 262.

linked with the highest Jurassic fishes by the Scopeloids, which occur throughout Cretaceous formations in great abundance and variety. Next to the Elopines and Clupeoids, in fact, the Scopeloids are the most characteristic fishes of the Cretaceous fauna. Some of them are almost identical with genera which still live in the deep sea, but nearly all have the bones so stout and well calcified that they must have been surface-dwellers. They, like many other Cretaceous types of fishes, have, therefore, probably migrated to the ocean depths during the Tertiary period as the competition from newer types of fishes has increased.[1]

The Cretaceous Dercetidæ are also primitive teleosteans whose surviving relatives live in the deep sea. They, again, have a well-hardened skeleton, but it is interesting to note that one known specimen exhibits traces of the distensible stomach which is so common a feature in abyssal types (see p. 69). They seem to have become extinct at the end of the Cretaceous period, but the Halosauridæ, which lived with them, are still well represented in the ocean depths, and the skeleton of the typical existing genus *Halosaurus* can scarcely be distinguished from that of *Echidnocephalus* found in the Upper Senonian of Westphalia.

The gradations between the Cretaceous groups already mentioned and the highest Jurassic fishes are not difficult to perceive; but the connection between the Apodes, or eels, and their predecessors, is not yet evident. That these fishes are the degenerate latest members of an old group is shown, among other features, by their long-bodied shape, the continuous extension of their median fins, and the absence of pelvic fins; but the Upper Cretaceous *Urenchelys*[2] only makes a slight approach towards its normally fish-shaped ancestors in still exhibiting a separate caudal fin, while the contemporaneous *Anguillavus*[3] merely adds to this primitive character the retention of the pelvic fins. Below the Upper Cretaceous no fishes have hitherto been discovered tracing the line of eels further back; and the fact that some of the generalised forms, even in the existing fauna, have more than five basal bones in their pectoral fins, suggests that the direct ancestors are to be found, not among the so-called teleosteans, but in some of the Jurassic "ganoids." It might be profitable to make a detailed study of the Macrosemiidæ in this connection.

The Cretaceous Clupeoids are chiefly of interest on account of their precocious development. They do not differ much from some of the Jurassic Leptolepidæ, but it is remarkable that so far back as the Lower Cretaceous, both in Switzerland[4]

[1] A. S. Woodward, "The Antiquity of the Deep-Sea Fish-Fauna," Natural Science, vol. xii (1898), pp. 257—260, pl. x.

[2] See especially A. S. Woodward, Catal. Foss. Fishes Brit. Mus., pt. iv (1901), pp. 337—339, pl. xviii, figs. 1—3.

[3] O. P. Hay, "On a Collection of Upper Cretaceous Fishes from Mount Lebanon, Syria," Bull. Amer. Mus. Nat. Hist., vol. xix (1903), pp. 437—441, pl. xxxvi, figs. 2, 3, pl. xxxvii, fig. 1.

[4] *Clupea antiqua* and *C. voironensis*, F. J. Pictet, "Foss. Terrain Néocom. Voirons" (Paléont. Suisse, 1858), pp. 31, 37, pl. iv, figs. 7—13, pl. v, figs. 1—10.

and in Brazil,[1] some of them had already acquired the row of sharp ventral ridge-scales which are so peculiar a feature of the surviving *Clupea* and allied genera. These fishes have not hitherto been found in the English Chalk, but individuals of at least one species are extremely abundant in the Upper Senonian of the Lebanon. An extinct family, that of the Ctenothrissidæ, confined to Upper Cretaceous formations, is precocious in another respect. The two known genera exhibit the pelvic fins so far forwards that their supports are in contact with the pectoral arch—a specialisation which is otherwise met with only in the highest fishes of the Acanthopterygian groups.

With these specialised Clupeoids there are others of a more generalised grade, beginning with *Crossognathus* from the Neocomian of Switzerland[2] and Hanover,[3] and represented in the English Chalk by *Syllæmus*. There are also, as might be expected, numerous Chirocentrids and Elopines, the former best known from the North American Chalk (see p. 99), the latter from the English Chalk and the Upper Cretaceous of the Lebanon and Brazil,[4] but both occurring also in Australia.[5] They, again, are very little higher in type than some of the highest Jurassic fishes; but very few Lower Cretaceous forms have been discovered, and until these are better known, possible origins can scarcely be discussed. With the Elopines in the Upper Cretaceous, there are specialised offshoots more or less closely related to the Albulidæ and Osteoglossidæ. These are represented only by fragments in the English Chalk, but the Albulid *Istieus* is known by numerous complete fishes from the Upper Senonian of Westphalia,[6] while *Anogmius* is well preserved in the Chalk of Kansas, U.S.A. (see p. 106).

Istieus is essentially identical with the surviving deep-sea genus *Bathythrissa;* and it is interesting to add that the imperfectly known *Tomognathus* from the English Chalk (see p. 139) also bears much resemblance to some of the low-grade teleosteans which are now confined to ocean depths. In fact, the more the Cretaceous bony fishes are examined, the more evident are their relationships to members of the existing abyssal fauna, rather than to fishes surviving in shallower depths.

Of the Cretaceous "ganoids," all the families become extinct before the

[1] *Diplomystus longicostatus*, E. D. Cope, Proc. Amer. Phil. Soc., vol. xxiii (1886), p. 3; A. S. Woodward, Ann. Mag. Nat. Hist. [6], vol. xv (1895), p. 2, pl. i, fig. 1.

[2] F. J Pictet, *op. cit.* (1858), p. 18, pl. ii, and pl. iv, figs. 1—6.

[3] A. S. Woodward, Catal. Foss. Fishes Brit. Mus., pt. iv (1901), p. 350.

[4] A. S. Woodward, "On the Fossil Teleostean Genus *Rhacolepis*, Agass.," Proc. Zool. Soc., 1887, pp. 535—541, pls. xlvi, xlvii; also Catal. Foss. Fishes Brit. Mus., pt. iv (1901), pp. 27—32.—D. S. Jordan and J. C. Branner, "The Cretaceous Fishes of Ceará, Brazil," Smithson. Miscell. Coll., vol. lii (1908), pp. 15—25, pls. iii—vii.

[5] *Ichthyodectes marathonensis*, R. Etheridge, jun., Rec. Australian Mus., vol. vi (1905), pp. 5—8, pls. i, ii.—*Portheus australis*, A. S. Woodward, Ann. Mag. Nat. Hist. [6], vol. xiv (1894), p. 444, pl. x, fig. 1.

[6] W. von der Marck, Palæontographica, vol. xi (1863), pp. 37—40, pls. iv, v; and *loc. cit.*, vol. xxii (1873), p. 59, pl. ii, fig. 2.

Tertiary period, except that of the Pycnodonts, which is occasionally found until the Upper Eocene, and possibly that of the Polyodontidæ, which is only doubtfully represented in the Chalk. They are, indeed, essentially Jurassic groups whose last specialised members are lingering just before their extinction. *Belonostomus* attains its maximum size, most powerful dentition, and most extensively ossified vertebræ. It also has a very wide distribution, being found not only from the Neocomian to the Senonian in Europe, but also occurring in North America,[1] Brazil,[2] and Australia.[3] *Protosphyræna* is the largest and latest Pachycormid, with the longest and most powerful rostrum, and the largest and strongest teeth; as common in the Upper Cretaceous of North America as in that of Europe, and known also by teeth from Patagonia.[4] *Lophiostomus* is a Eugnathid, but the bony prominences on its skull indicate that it has reached the climax of its race. *Neorhombolepis* from England, and *Otomitla* from Mexico,[5] have the vertebræ unusually well ossified, while the fulcra have disappeared from the fins, at least in the first-mentioned genus. Fishes of this type have a wide range both in time and space, for *Neorhombolepis* occurs in the Wealden of England as well as in the Chalk; while scales and vertebræ similar to those of this genus were found by Mr. Joseph Mawson and myself in 1907 in the Lower Cretaceous rocks of a railway cutting near Santa Amara, in the State of Bahia, Brazil. Of the Pycnodonts, the Cretaceous *Anomœodus* is unique in having the splenial incompletely covered with teeth; the dentition of *Gyrodus* (?) *cretaceus* exhibits a lack of orderly arrangement which suggests senility; while the skull and pectoral arch of *Coccodus* from the Lebanon[6] bear bony spinous prominences. Even *Macropoma*, which is the last of the race of Cœlacanths, is unusually specialised in the skull and in the scale-armature, and has lost the fringe of fin-rays at the end of the tail.

Apart from the relatively large size of most species, there is nothing worthy of remark in the Cretaceous Chimæroids. The Elasmobranchs, however, are more interesting, and some need special notice. Nearly complete skeletons are abundant in the Upper Senonian of the Lebanon,[7] and they occasionally occur in

[1] *Belonostomus ornatus*, J. Felix, Palæontographica, vol. xxxvii (1891), p. 192, pl. xxviii, figs. 14—18, pl. xxx, fig. 8.

[2] *Belonostomus comptoni*, A. S. Woodward, Proc. Zool. Soc., 1890, p. 629, pls. liv, lv.

[3] *Belonostomus sweeti*, Etheridge and Woodward, Trans. Roy. Soc. Victoria, vol. ii (1892), pt. ii, p. 3, pl. i.

[4] A. S. Woodward, Geol. Mag. [4], vol. iv (1897), p. 22.

[5] J. Felix, *loc. cit.* (1891), p. 189, pl. xxix, fig. 3, pl. xxx, figs. 3—5.

[6] A. S. Woodward, Catal. Foss. Fishes Brit. Mus., pt. iii (1895), p. 266; J. W. Davis, Quart. Journ. Geol. Soc., vol. xlvi (1890), p. 565, pl. xxii.

[7] See especially F. J. Pictet, Description de quelques Poissons Fossiles du Mont Liban (Geneva, 1850); F. J. Pictet and A. Humbert, Nouvelles Recherches sur les Poissons Fossiles du Mont Liban (Geneva, 1866); J. W. Davis, "The Fossil Fishes of the Chalk of Mount Lebanon in Syria," Trans. Roy. Dublin Soc. [2], vol. iii (1887), p. 457; O P. Hay, Bull. Amer. Mus. Nat. Hist., vol. xix (1903), art. x; also Catal. Foss. Fishes Brit. Mus., pt. i (1889).

corresponding formations in Westphalia and elsewhere. Most of the Scylliidæ and Lamnidæ are evidently referable to genera which survive in existing seas, though one of these, *Scapanorhynchus*, is now rare and restricted in its range. The extinct genus *Corax* is especially noteworthy, because its vertebral centra are very similar to those of the existing basking shark, *Selache*, while the teeth of one of the latest species, *Corax affinis*, approach those of *Selache* in shape and might easily be modified into the latter. *Corax* may indeed be the Cretaceous ancestor of the Tertiary *Selache*. *Cestracion* seems to have undergone no essential change during its long existence from the Upper Jurassic to the present day; but the typically Cretaceous Hybodont, *Synechodus*, survived only until the Eocene. *Ptychodus* is a primitive skate, represented for the most part by gigantic species, which occur only in the Upper Cretaceous, and seem to have become extinct before the end of the period. Though common in the Chalk of England and North America, its remains have not hitherto been found in the prolific fish-beds of Westphalia, the Lebanon, or Persia. Its Lower Cretaceous predecessors remain unknown, but certain Upper Cretaceous fossils suggest that some descendants may be found among the Tertiary and Recent Myliobatidæ.

As a whole, therefore, the Cretaceous fish-fauna is much more modern in aspect than the contemporaneous reptile-fauna and mammal-fauna; and in its latest phase the Acanthopterygians at least must have undergone remarkably rapid evolution.

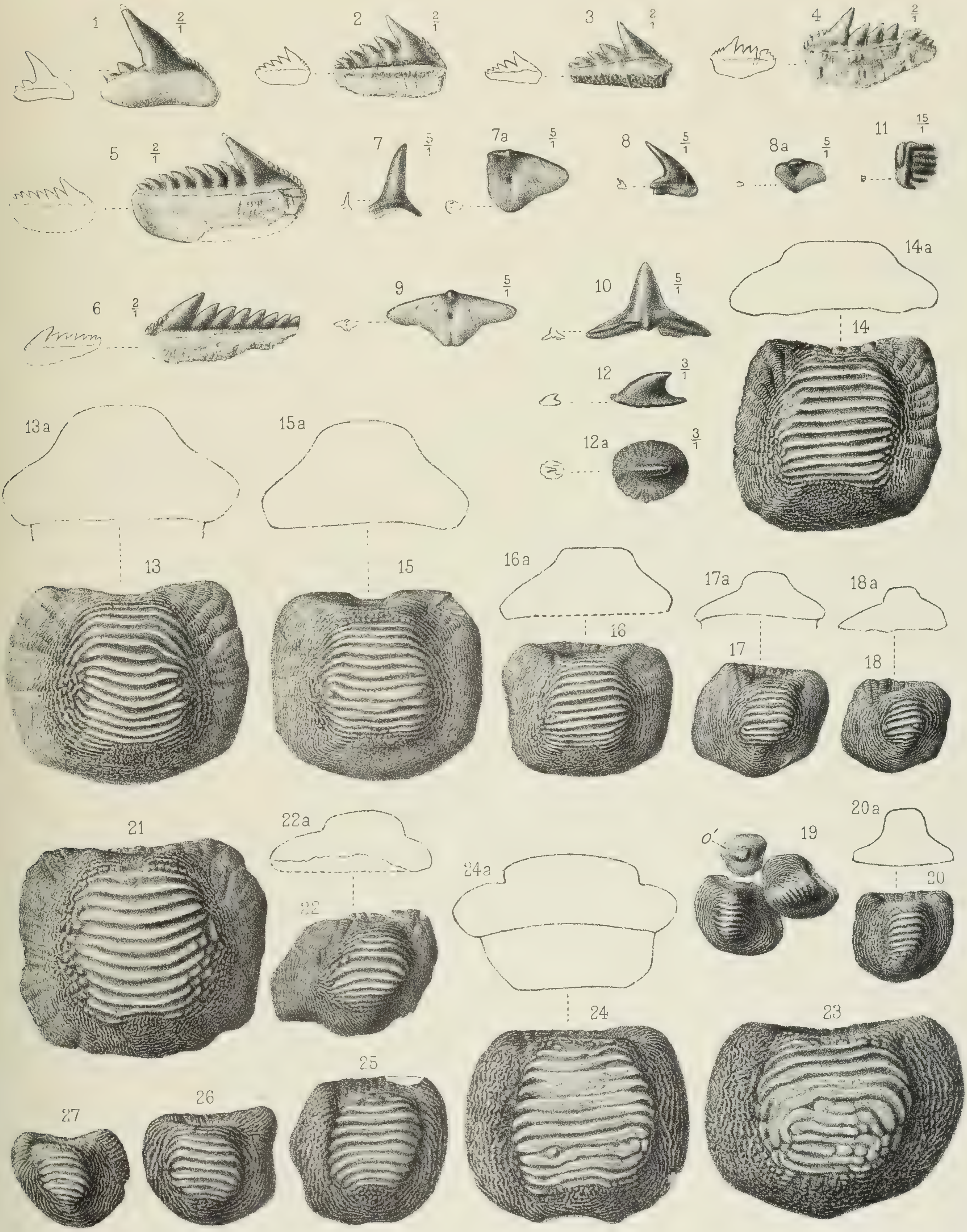
INDEX.

Numerals in *italics* indicate casual references.

ADLARD AND SON, IMPR., LONDON AND DORKING.

PLATE XLVII.

Fig.		Page.
1.	*Notidanus microdon*, Agassiz; anterior upper tooth, inner view, twice nat. size.—Zone of *Belemnitella mucronata;* Norwich. B. M. no. 24927.	222.
2, 3.	Ditto; two lateral upper teeth, outer and inner view respectively, twice nat. size.—Chalk; Kent. Harford Collection (B. M. no. P. 5596).	223.
4.	Ditto; lateral lower tooth, outer view, twice nat. size.—Zone of *Marsupites* (*Uintacrinus*-band); near Salisbury. Dr. H. P. Blackmore's Collection.	223.
5, 6.	Ditto; two lateral lower teeth, outer and inner view respectively, twice nat. size.—Zone of *Belemnitella mucronata;* Norwich. Bayfield Collection (B. M. nos. 35648, 48950).	223.
7–12.	*Squatina cranei*, A. S. Woodward; crown of anterior teeth (7, 8) and basal view of root of same (7 *a*, 8 *a*), basal view of root (9) and outer view of crown (10) of lateral teeth, five times nat. size; also shagreen granule (11), fifteen times nat. size, and spinous tubercle in side view (12) and from above (12 *a*), three times nat. size.—Zone of *Holaster subglobosus;* Clayton, Sussex. Willett Collection no. 183, Brighton Museum.	224.
13–18.	*Ptychodus mammillaris*, Agassiz; associated set of teeth, one (13) from lower middle row, another (14) from upper inner paired row, and the others (15–18) also from paired rows, crown-view and outline-section of crown, nat. size.—Chalk; Guildford, Surrey. B. M. no. 27032.	230.
19, 20.	Ditto; associated teeth of inner paired rows and (o′) upper middle row, nat. size.—Chalk; near Chatham, Kent. Bowerbank Collection (B. M. no. 39127).	231.
21, 22.	Ditto; two associated teeth, crown-view and (22 *a*) the smaller crown in outline-section, nat. size.—Turonian zone; Lewes, Sussex. B. M. no. P. 5389.	231.
23–27.	Ditto: associated teeth of coarsely-marked variety, crown-view and one (24 *a*) also in outline-section, nat. size.—Ibid. Mantell Collection (B. M. nos. 4391, 4388, 4389, 4408, 4446).	231.



A.H. Searle del. et lith.

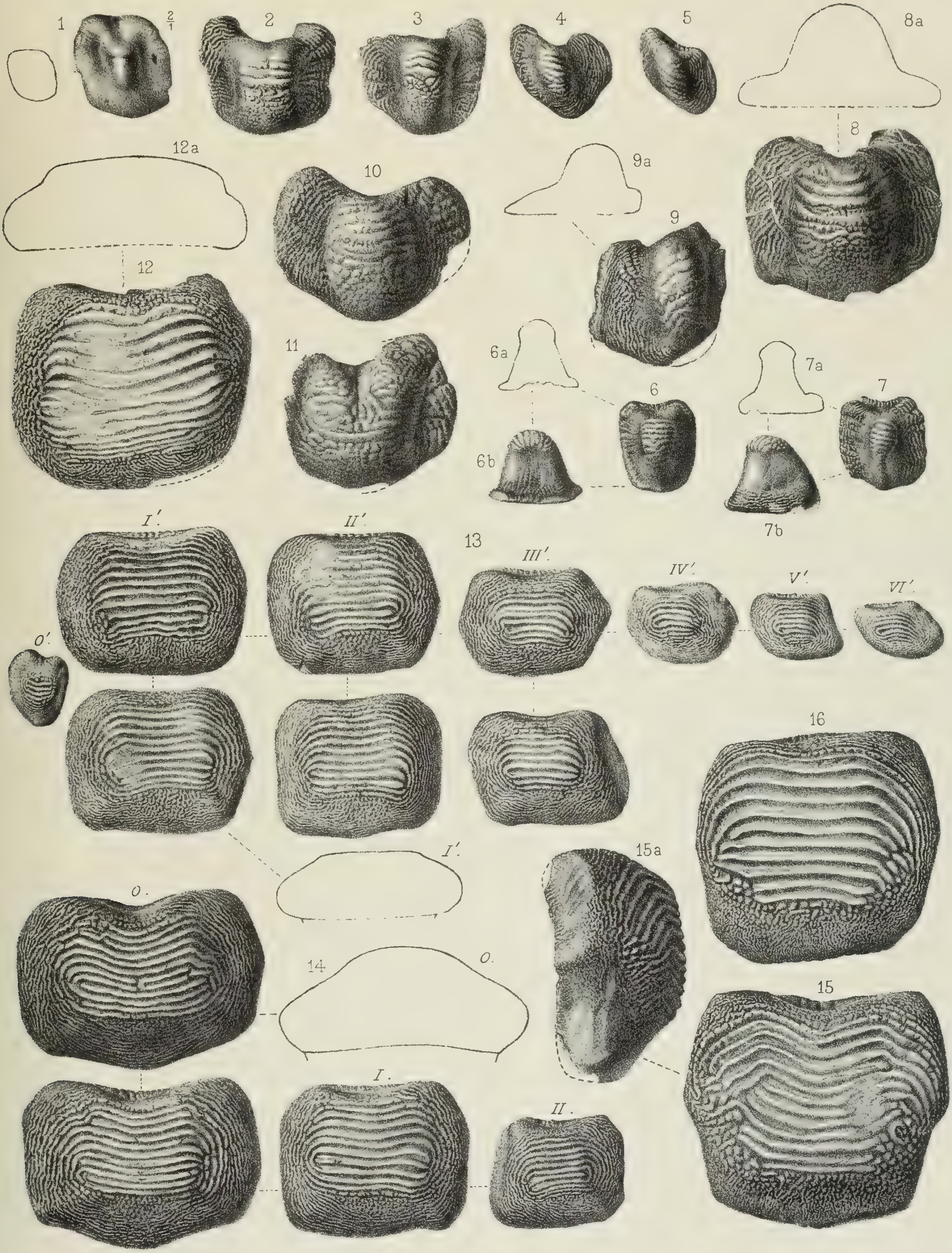
West, Newman imp.

1–6. Notidanus. 7–12. Squatina. 13–27. Ptychodus.

PLATE XLVIII.

Fig.		Page.
1–5.	*Ptychodus rugosus*, Dixon; associated teeth, crown-view, one (1) of upper middle row, twice nat. size, the others of paired rows, nat. size.—Zone of *Micraster coranguinum;* Purley, Surrey. B. M. no. 39793.	232.
6.	Ditto; tooth, crown-view, outline-section (6 *a*), and side view (6 *b*), nat. size.—Senonian zone; Sussex. Mantell Collection (B. M. no. 4428).	232.
7.	Ditto; tooth, crown-view, outline-section (7 *a*), and side view (7 *b*), nat. size.—Ibid. Dixon Collection (B. M. no. 28247).	232.
8–11.	Ditto: associated teeth, crown-view, and two (8 *a*, 9 *a*) also in outline-section of crown, nat. size.—Senonian zone; Kent. Taylor Collection (B. M. nos. 33249, 32352).	232.
12.	*Ptychodus polygyrus* var. *marginalis*, Agassiz; one of the type teeth, crown-view and (12 *a*) outline-section of crown.—Turonian zone; Lewes. Mantell Collection (B. M. no. 4385).	234.
13, 14.	Ditto; associated set of teeth of various upper and lower rows indicated by lettering, nat. size.—Zone of *Terebratulina gracilis;* Wouldham, Kent. G. E. Dibley Collection (B. M. no. P. 10464).	234.
15, 16.	Ditto; associated teeth of lower middle (15) and upper inner paired rows (16), both in crown-view, the first also in side view to show two pressure scars (15 *a*), nat. size.—Chalk; Beachy Head, Sussex. B. M. no. P. 6141.	235.

A.S. Woodward, English Chalk Fishes. Pl. XLVIII.

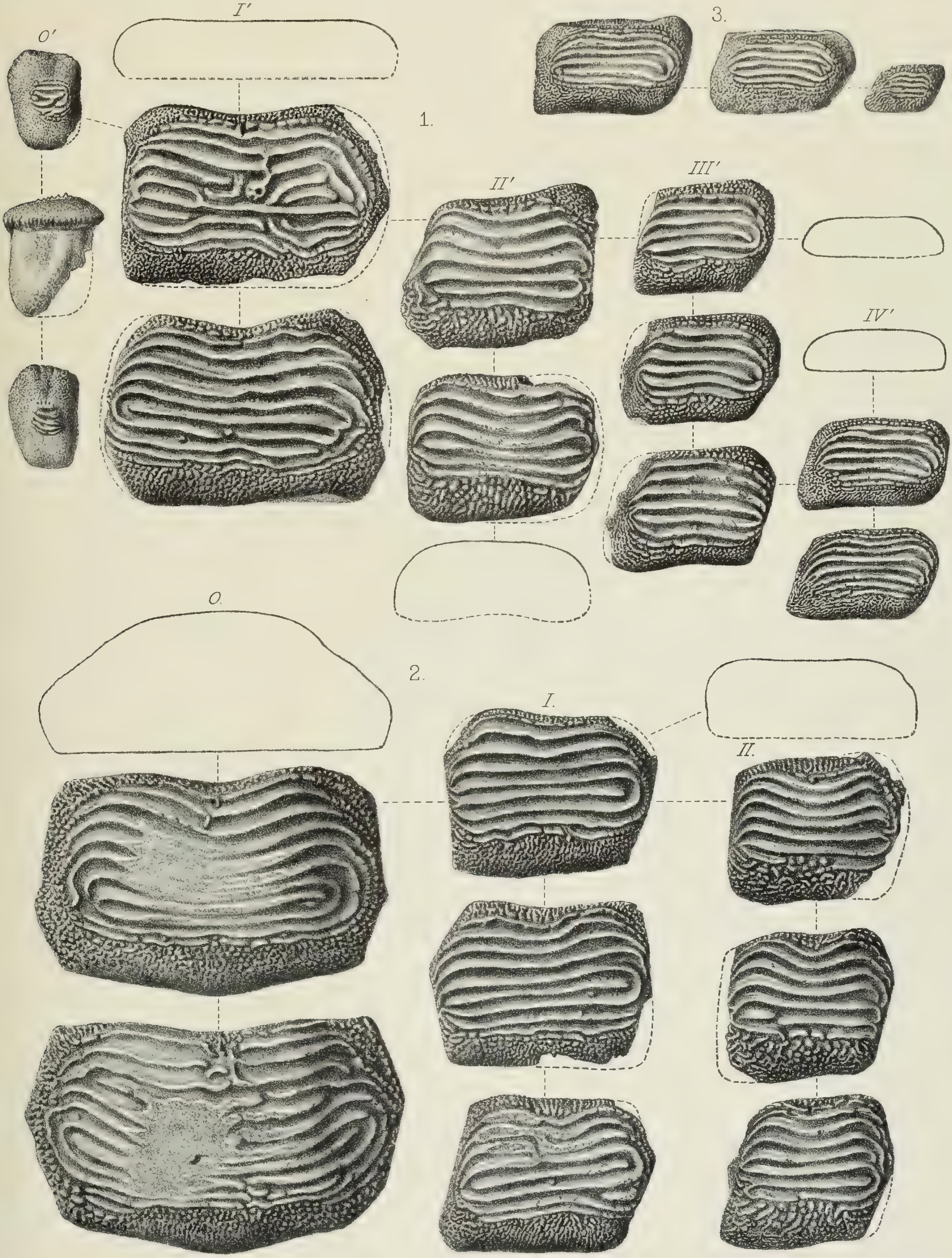


A.H. Searle del. et lith. West, Newman imp.

Ptychodus.

PLATE XLIX.

Fig.		Page.
1.	*Ptychodus polygyrus*, Agassiz; associated upper teeth of rows o′ to IV′, crown-views, with one tooth of o′ in side view, and an outline-section of the crown of one tooth in each other row, nat. size.—Zone of *Micraster coranguinum;* Banstead, Surrey. B. M. no. P. 10771.	233.
2.	Ditto; lower teeth of rows o to II of the same specimen, crown-views and two outline-sections, nat. size.	234.
3.	Ditto; teeth of three lateral paired rows of the same specimen, crown-views, nat. size.	234.



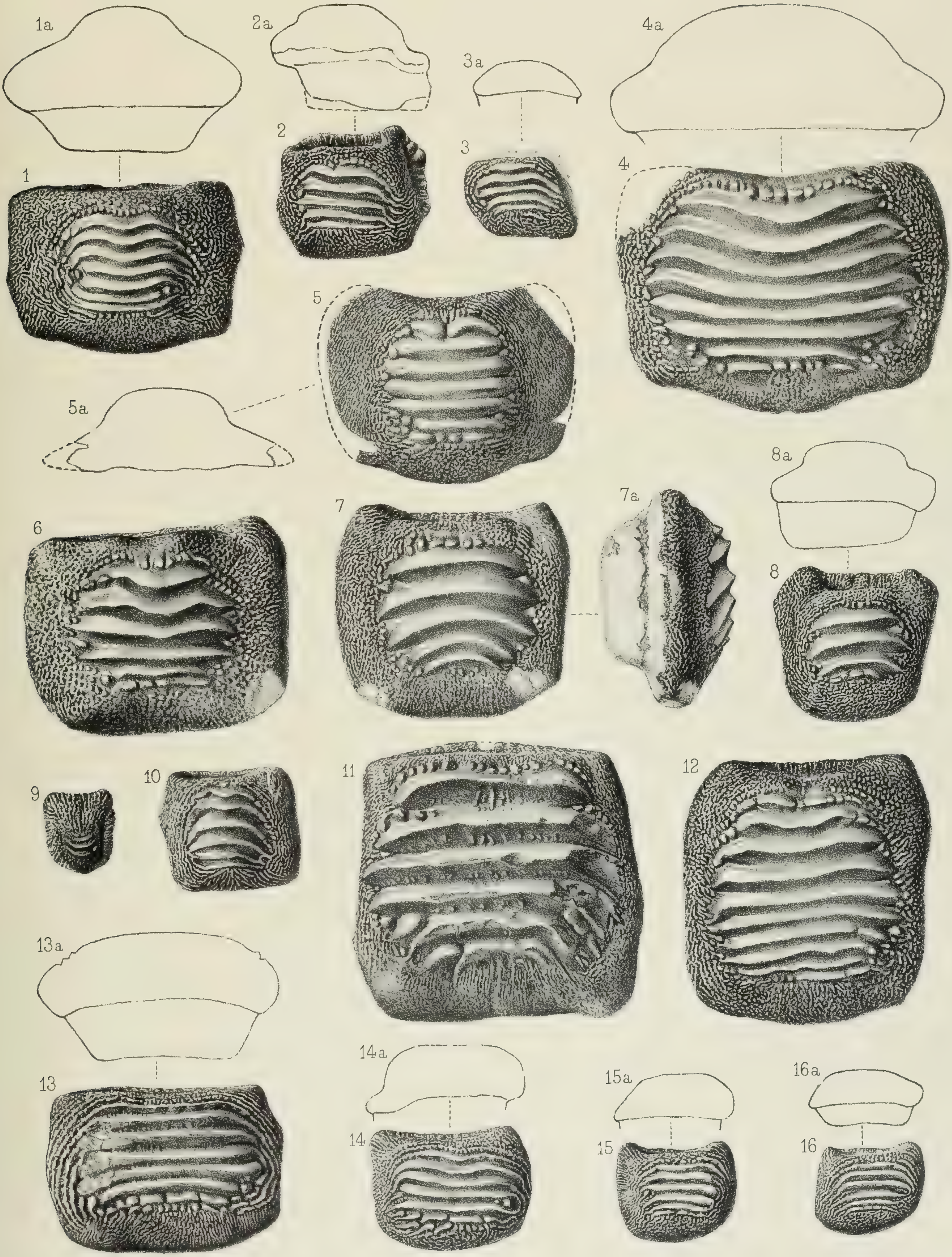
A. H. Searle del. et lith.

West, Newman imp.

Ptychodus.

PLATE L.

Fig.		Page.
1–3.	*Ptychodus latissimus*, Agassiz; three associated teeth of one of the type specimens, in crown-view and outline-section (1 *a*–3 *a*), nat. size. Figs. 1, 1 *a*, represent a lower middle tooth.—Turonian zone; near Lewes. Mantell Collection (B. M. no. 4355).	236.
4.	Ditto; lower middle tooth, in crown-view and outline-section of crown (4*a*), nat. size.—Chalk; Hertford. B. M. no. P. 5864.	237.
5.	Ditto; lower middle tooth, in crown-view and outline-section of crown (5*a*), nat. size.—Chalk; Suffolk. Wetherell Collection (B. M. no. 37350).	237.
6–8.	Ditto; associated lower middle tooth, crown-view (6), upper inner paired tooth, crown-view (7) and side view (7 *a*), and lateral tooth, crown-view (8) and outline-section (8 *a*), nat. size.—Turonian zone; Burham, Kent. Harford Collection (B. M. no. P. 5603).	237.
9, 10.	Ditto; associated upper middle tooth (9) and lateral tooth (10), crown-views, nat. size.—Turonian zone; near Lewes. Mantell Collection (B. M. no. 4358).	238.
11.	Ditto; tooth of upper inner paired row, crown-view, nat. size.—Chalk; Orford, Suffolk. B. M. no. 36103.	238.
12.	Ditto; tooth of upper inner paired row, crown-view, nat. size.—Chalk; near Croydon, Surrey. Bowerbank Collection (B. M. no. 39129).	238.
13–16.	Ditto; associated upper teeth of the form named *P. dixoni*, Dibley, crown-views and outline-sections (13 *a*–16 *a*), nat. size.—Zone of *Terebratulina gracilis;* Cuxton, Kent. Dibley Collection (B. M. no. P. 10260).	238.



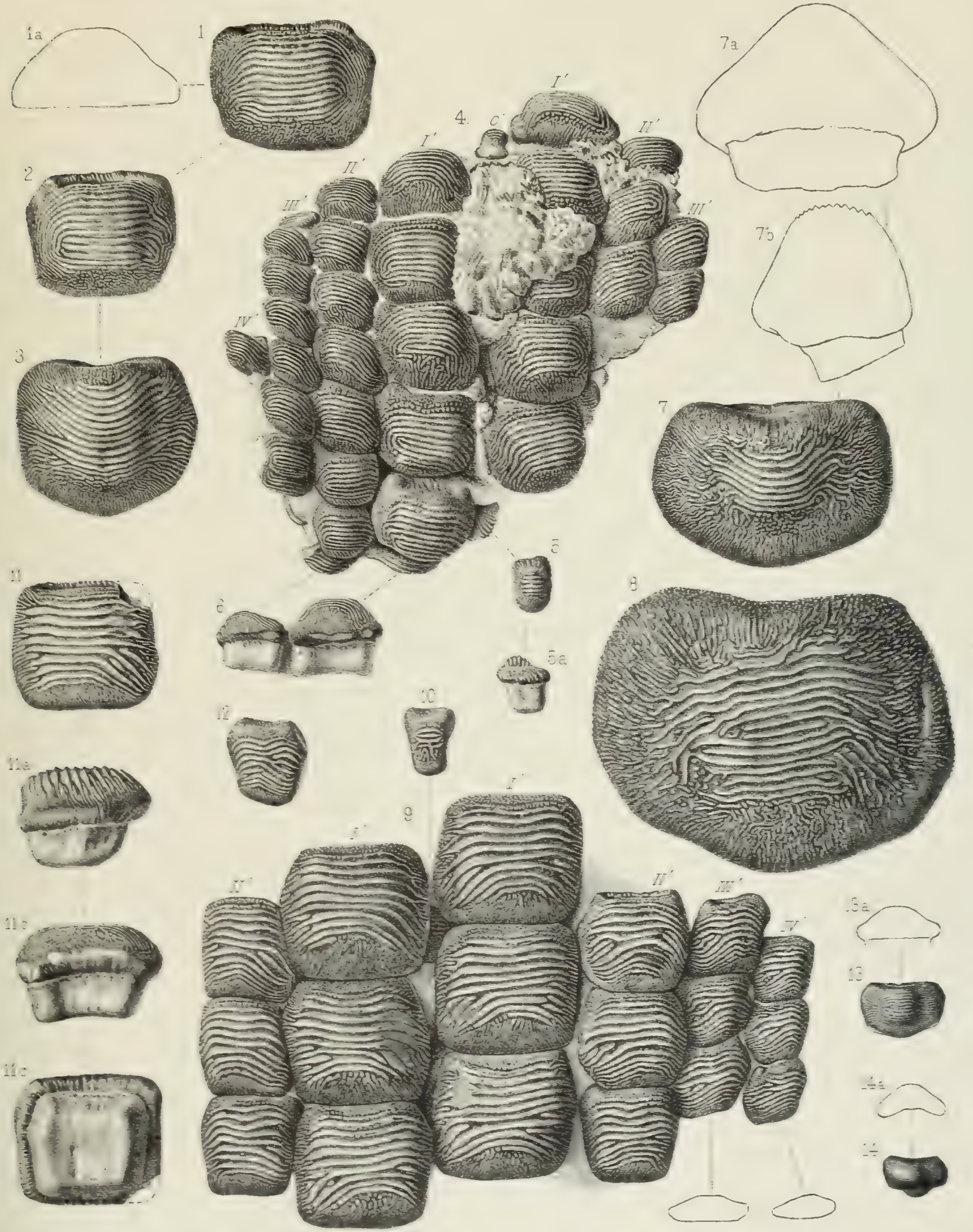
A. H. Searle del. et lith.

West, Newman imp.

Ptychodus.

PLATE LI.

Fig.		Page.
1–3.	*Ptychodus decurrens*, Agassiz; associated teeth of paired (1, 2) and lower middle (3) rows, crown-views, the crown of the first also in outline-section (1 *a*), nat. size.—Turonian zone; near Lewes. B. M. no. P. 5393.	244.
4–6.	Ditto; set of upper teeth united in natural order by iron pyrites, oral view, nat. size, one middle tooth being drawn separately in crown-view (5) and side view (5 *a*), and two inner paired teeth in front view (6).—Zone of *Holaster subglobosus;* Glynde, Sussex. Sedgwick Museum, Cambridge. Rows numbered o′ to iv′.	243.
7.	Ditto; lower middle tooth, crown-view, with outline-sections, transverse (7 *a*) and longitudinal (7 *b*), nat. size.—Chalk; Kent. B. M. no. 43096.	241.
8.	Ditto; large, irregularly-developed upper inner paired tooth, crown-view, nat. size. — Zone of *Holaster subglobosus;* Burham, Kent. B. M. no. 32748.	242.
9–12.	Ditto; set of upper teeth united in natural order in chalk, oral view, nat. size, one middle tooth being drawn separately in crown-view (10), a tooth of the inner paired row being separately shown in crown-view (11), side view (11 *a*), front view (11 *b*), and from below (11 *c*), also a tooth of the fourth lateral row in crown-view (12).—Ibid. G. E. Dibley Collection (B. M. no. P. 10336). Lateral rows numbered i′ to iv′.	242.
13.	Ditto; small smooth tooth, var. *levis*, in crown-view and (13 *a*) outline-section, nat. size.—Zone of *Holaster subglobosus;* Blue Bell Hill, Burham, Kent. S. J. Hawkins Collection (B. M. no. P. 6524).	240.
14.	Ditto; small tooth of similar variety, in crown-view and (14 *a*) outline-section, nat. size.—Zone of *Holaster subglobosus;* Dover. B. M. no. P. 51.	240.

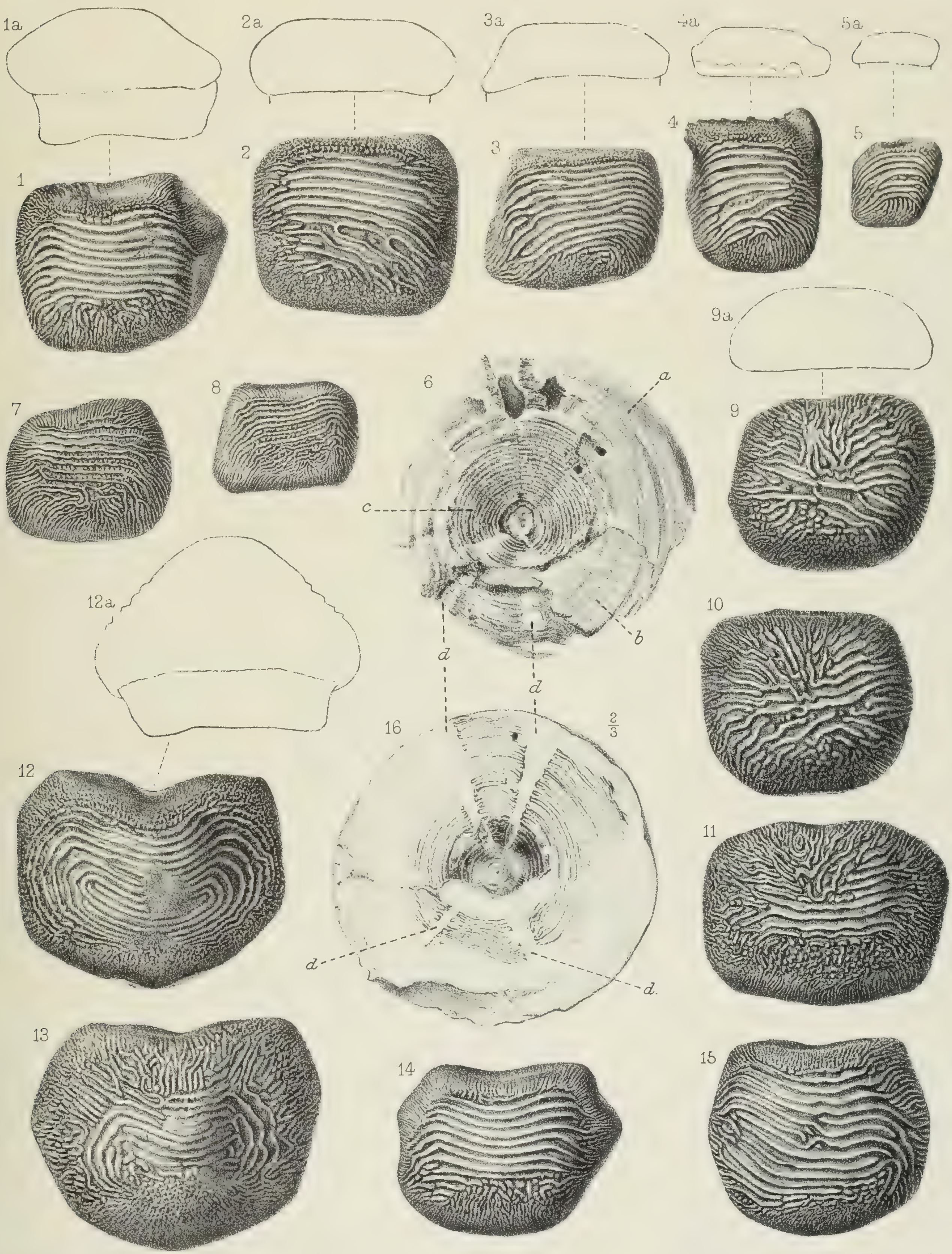


A. H. Searle del. et lith. West Newman imp.

Ptychodus

PLATE LII.

Fig.		Page.
1–5.	*Ptychodus decurrens*, Agassiz; five associated teeth, crown-views and (1 *a*–5 *a*) outline-sections, nat. size.—English Chalk. Bowerbank Collection (B. M. no. 39436).	242.
6.	Ditto; imperfect vertebral centrum associated with the preceding teeth, nat. size. *a.*, outer smooth face of primitive double-cone; *b.*, inner face of the same, showing delicate radiating ridges; *c.*, concentric laminæ within; *d.*, vacant spaces originally occupied by cartilage continuing base of neural or hæmal arch.	228.
7, 8.	Ditto; two associated teeth, crown-views, showing tubercles between ridges, nat. size.—Zone of *Holaster subglobosus;* Wouldham, Kent. Bowerbank Collection (B. M. no. 39138).	242.
9–11.	Ditto; var. *oweni*, Dixon; three apparently associated teeth, crown-views and the first in outline-section (9 *a*), nat. size.—Zone of *Holaster subglobosus;* Halling, Kent. Bowerbank Collection (B. M. no. 39125).	242.
12–15.	Ditto; four associated teeth, crown-views, and the first in outline-section (12 *a*), nat. size.—Zone of *Holaster subglobosus;* Holborough, near Rochester, Kent. G. E. Dibley Collection (B. M. no. P. 10261).	244.
16.	Ditto; median section of vertebral centrum, showing concentric laminæ and spaces for cartilage at the bases of the neural and hæmal arches (*d.*), two thirds nat. size.—Chalk; Kent. Mrs. Smith's Collection (B. M. no. 49016).	228.



A.H.Searle del.et lith.

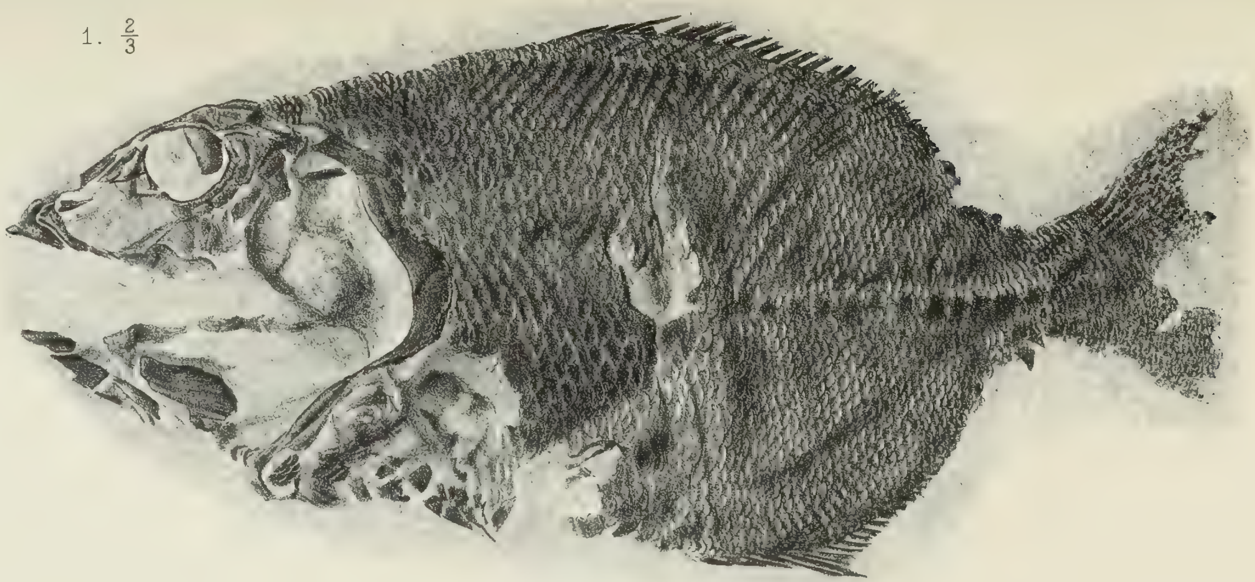
West, Newman imp.

Ptychodus.

PLATE LIII.

Fig.		Page.
1.	*Berycopsis elegans*, Dixon; imperfect fish in left side view, two thirds nat. size.—Zone of *Holaster subglobosus;* Halling, Kent. W. E. Balston Collection (B. M. no. P. 10001).	245.
2.	*Aulolepis typus*, Agassiz; imperfect fish in left side view, nat. size.—English Chalk. Sedgwick Museum, Cambridge. *a.*, anal fin; *c.*, caudal fin; *do.*, dorsal fin; *plv.*, pelvic fins.	247.

1. $\frac{2}{3}$



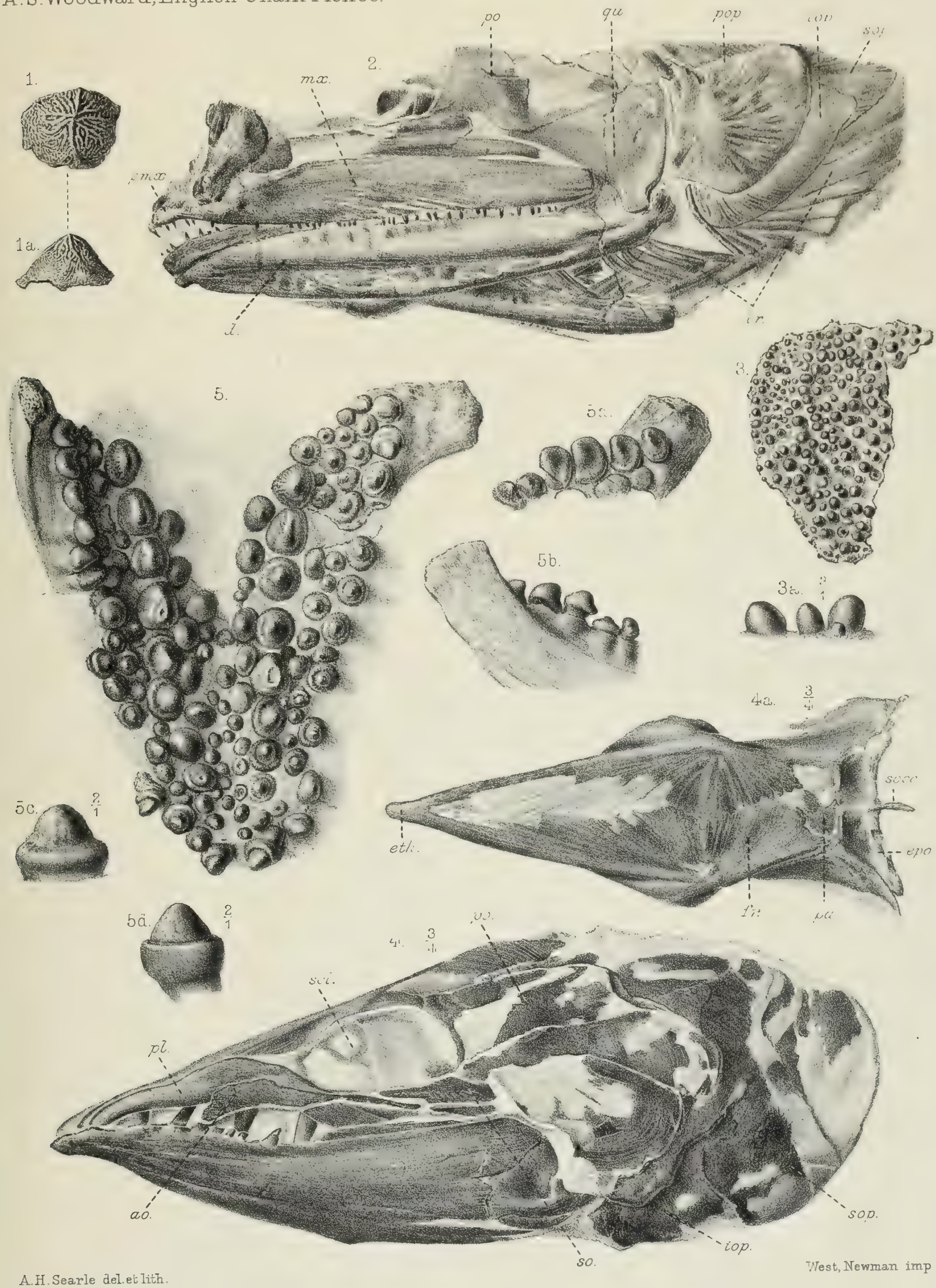
2.

A. H. Searle del. et lith.
West, Newman imp.

1. Berycopsis. 2. Aulolepis.

PLATE LIV.

FIG.		PAGE.
1.	*Ptychodus* aff. *mortoni*, Mantell; imperfect crown of tooth, oral and (1 *a*) anterior views, nat. size.—Chalk; Winchester. Oxford Museum.	244.
2.	*Pachyrhizodus* sp.; lower portion of head and opercular apparatus, left side view, nat. size.—Zone of *Holaster subglobosus;* South Ferriby, Lincolnshire. Collection of Henry C. Drake, Esq., F.G.S. *br.*, branchiostegal rays; *d.*, dentary; *iop.*, interoperculum; *mx.*, maxilla; *pmx.*, premaxilla; *po.*, postorbital plate; *pop.*, preoperculum; *qu.*, quadrate; *sop.*, suboperculum.	249.
3.	Dentition probably of parasphenoid of an Elopine or Albulid fish, oral view, nat. size, with (3 *a*) three teeth enlarged three times.—Zone of *Holaster subglobosus;* Wouldham, Kent. G. E. Dibley Collection (B. M. no. P. 10952).	250.
4.	*Apateodus striatus*, A. S. Woodward; head, left side view, with (4 *a*) upper view of skull, three quarters nat. size.—Zone of *Holaster subglobosus;* Brockham, Surrey. Museum of Practical Geology. *ao.*, antorbital; *epo.*, epiotic; *eth.*, mesethmoid; *fr.*, frontal; *iop.*, interoperculum; *pa.*, parietal; *pl.*, palatine; *po.*, postorbital; *scl.*, sclerotic; *so.*, suborbital; *socc.*, supraoccipital; *sop.*, suboperculum.	246.
5.	*Gyrodus* (?) *cretaceus*, Agassiz; mandible with dentition, oral view, nat. size, with inner (5 *a*) and outer (5 *b*) views of the coronoid end of the right splenial, also nat. size, and a posterior principal tooth (5 *c*) and an anterior tooth (5*d*) in side view, twice nat. size.—Zone of *Terebratulina gracilis;* Cuxton, Kent. Collection of George Hutchings, Esq.	251.



A. H. Searle del. et lith.

West, Newman imp.

1. Ptychodus. 2, 3. Elopines. 4. Apateodus. 5. Gyrodus.

Palæontographical Society, 1911.

A MONOGRAPH

OF THE

CRETACEOUS LAMELLIBRANCHIA

OF

ENGLAND.

BY

HENRY WOODS, M.A.

UNIVERSITY LECTURER IN PALÆOZOOLOGY, CAMBRIDGE.

VOL. II. PART VIII.

INOCERAMUS (*continued*).

PAGES 285—340; PLATES LI—LIV.

LONDON:

PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.

1912.

PRINTED BY ADLARD AND SON, LONDON AND DORKING.

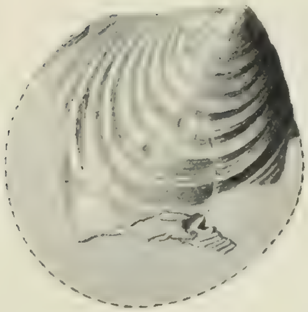


Fig. 41.—*Inoceramus labiatus* var. *latus*, Sow. Zone of *Holaster planus*, Coombe Bissett. Dr. Blackmore's Collection. Right valve. Natural size.

Inoceramus inconstans, sp. nov. Plate LI, figs. 1—4. Text-figs. 39, 42—49.

1822. Inoceramus Brongniarti, var., *G. Mantell.* Foss. S. Downs, p. 215, pl. xxviii, fig. 3.
— — sp. *Mantell.* Ibid., p. 217, pl. xxvii, fig. 9.
1850. — Lamarckii, *J. de C. Sowerby* in *F. Dixon.* Geol. Sussex, p. 355 (p. 385, ed. 2), pl. xxviii, fig. 29.
1904. — Brongniartii, *C. Airaghi.* Boll. Soc. geol. Italiana, vol. xxiii, p. 192, pl. iv, figs. 3—5.

Description.—Shell extremely inequilateral, moderately or slightly inequivalve; the early part of the shell slightly convex or nearly flat, the later part much more convex and sometimes growing nearly perpendicularly to or forming a large angle with the early part, so that in old individuals the shell becomes more inflated; in other cases the convexity increases more gradually from the earlier to the later stages of growth and a nearly globose shell results. Height of the shell often rather greater than the length. Hinge-line long, forming rather more than a right angle with the anterior margin, which is usually more or less nearly straight. Ventral and posterior margins rounded. Umbones terminal, small, pointed, only slightly curved. Anterior marginal part of the valve usually flattened, but not definitely limited from the sides of the shell. Posterior ear developed but not distinctly limited.

Concentric folds are usually well developed, but become indistinct on the anterior flattened area, on the posterior ear, and on the later part of the valve of old individuals. The concentric folds have a very unsymmetrical curvature.

Remarks.—The forms included in this species vary considerably, owing mainly to the length of duration of the flattened stage, which in some individuals forms a

small part (Figs. 43, 48, 49) but in others a large part (Plate LI, fig. 2, Text-figs. 45, 46) of the entire shell.[1] Also the passage from one stage to the other is sometimes gradual, so that the section of the shell forms a fairly uniform curve (Fig. 48), but generally the change is abrupt, so that the later part of the valve is

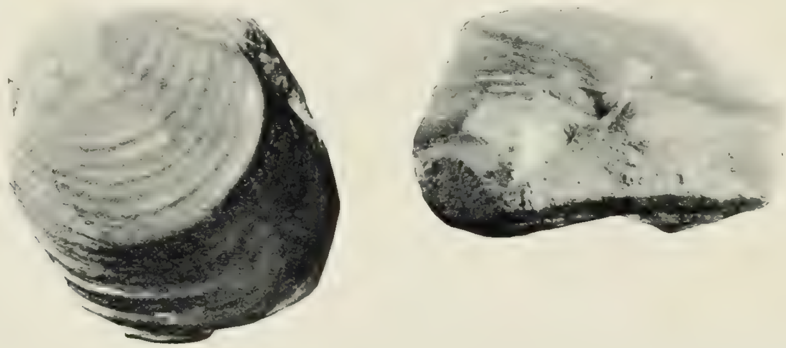


Fig. 42.—*Inoceramus inconstans*, sp. nov. The original of *Inoceramus* sp., Mantell, 'Foss. S. Downs,' p. 217, pl. xxvii, fig. 9. Upper Chalk, Lewes. British Museum, No. 4765. Left valve and posterior view. Natural size.

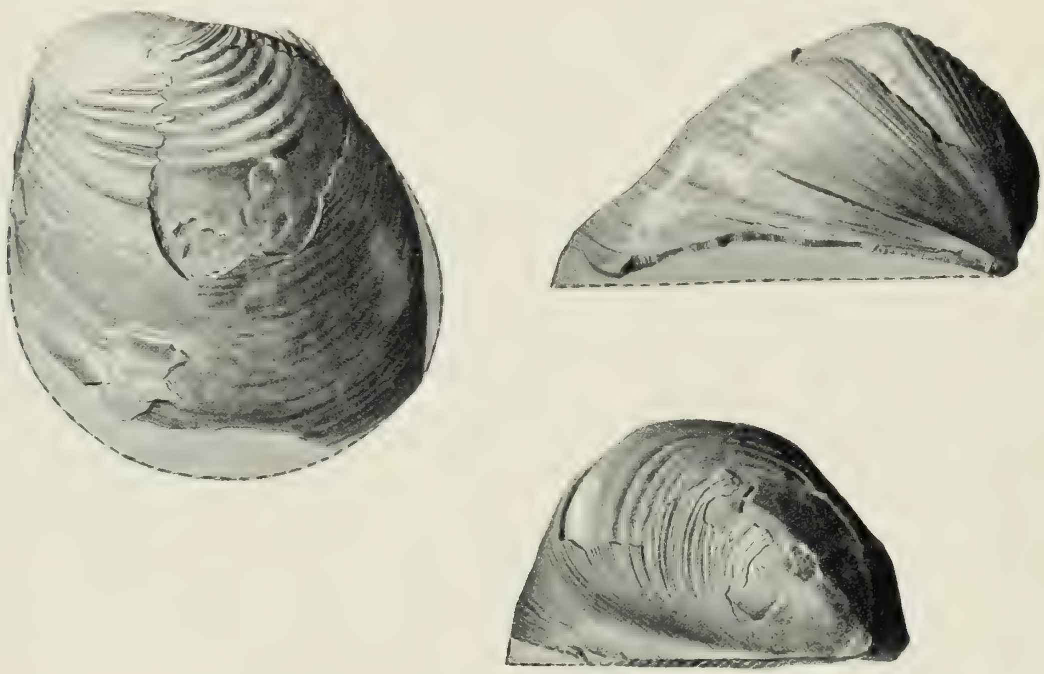


Fig. 43.—*Inoceramus inconstans*, sp. nov. Zone of *Holaster planus*, Swaffham, Norfolk. Norwich Museum. Left valve, and posterior and dorsal views of the same. Natural size.

bent at an angle with the earlier part (Figs. 42, 43). The length of the hinge-line in proportion to the height of the shell shows some variation and consequently the

[1] The larger specimen of *I. latus*, Sowerby ('Min. Conch.,' vol. vi, pl. dlxxxii, upper figure), which cannot now be found, is probably an example of this.

Fig. 44.

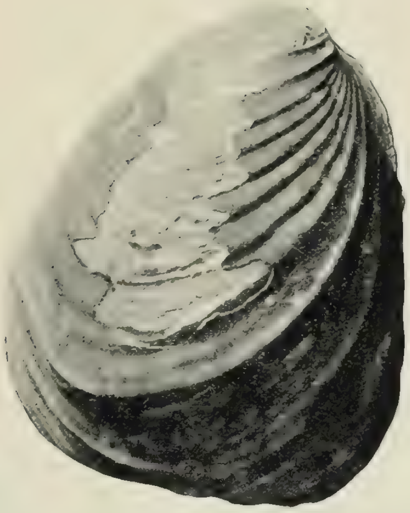


Fig. 45.

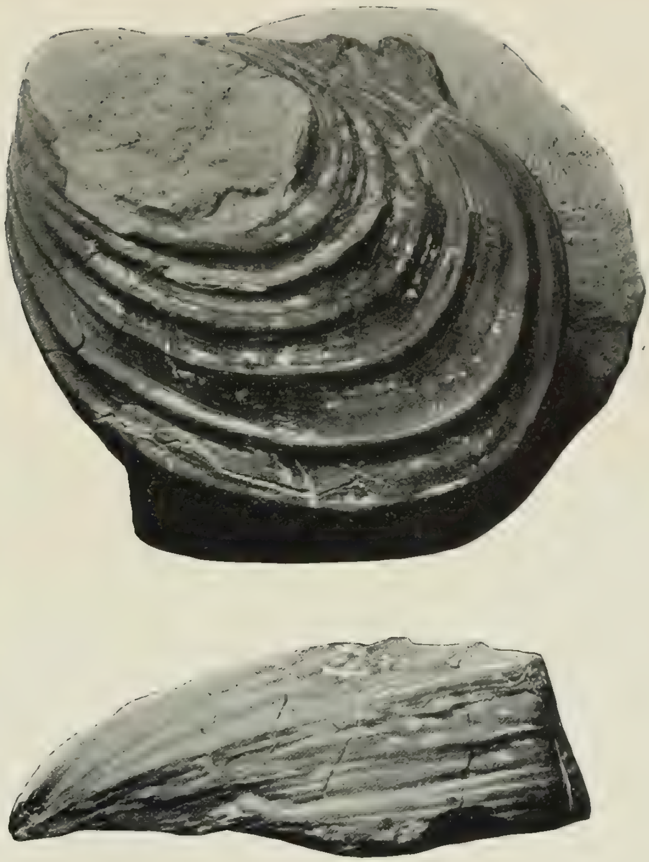


Fig. 44.—*Inoceramus inconstans*, sp. nov. The original of *I. Brongniarti*, var., Mantell, 'Foss. S. Downs,' p. 215, pl. xxviii, fig. 3. Upper Chalk (probably zone of *Micraster cor-anguinum*), Southeram. British Museum, No. 5878. Right valve. Natural size.

Fig. 45.—*Inoceramus inconstans*, sp. nov. Upper Chalk, Sussex. British Museum, No. 5866. Left valve and anterior view. Natural size.

Fig. 46.—*Inoceramus inconstans*, sp. nov. Zone of *Holaster planus*, Swaffham, Norfolk. Norwich Museum. Right valve. Natural size.

curvature of the ribs varies. In some specimens (often of large size) the shell is thinner than usual and has sharp and ridge-like folds similar to those of *I. Lamarcki* var. *Websteri*, Mant. (p. 318). Further work may show that it is desirable to give names to some of the varieties of *I. inconstans*.

Affinities.—This species is closely allied to *I. labiatus* var. *latus*, Sowerby;[1] but the hinge is relatively longer and the height of the shell less, the anterior flattened area is larger, the later part of the shell is more convex, the umbones are less prominent and the posterior ear more distinct.

Fig. 47.—*Inoceramus inconstans*, sp. nov. Upper Chalk (zone of *Actinocamax quadratus*), Brighton. Brighton Museum, No. 336. Right valve and anterior view. Natural size.

I. inconstans is distinguished from *I. Lamarcki*, Parkinson (p. 307), by the relatively longer hinge-line, the more unsymmetrical curvature of the folds, the flattened form of the early part of the shell, the less prominent umbones, and the smaller difference in the size of the valves. *I. Cuvieri* of Andert[2] appears to be a flat form of *I. inconstans*. Another specimen figured by Andert[3] is allied to *I. inconstans*, but its axis of growth is more oblique and its hinge longer than usual.

[1] *Erratum* on p. 284 (fig. 39): for *Inoceramus labiatus* var. *latus*, Sow., read *Inoceramus inconstans*, sp. nov. A specimen figured by Andert ('Inoceramen d. Kreibitz-Zittauer Sandsteingeb.,' 1911, p. 45, pl. i, fig. 5) as *I. Cuvieri* var. *planus* appears to be intermediate between *I. labiatus* and *I. labiatus* var. *latus*.

[2] *Loc. cit.*, pl. ii, fig. 2.

[3] *Loc. cit.*, pl. i, fig. 2, pl. vii, fig. 8 (*I. Cuvieri* var. *planus*).

FIG. 48.—*Inoceramus inconstans*, sp. nov. Upper Chalk. Locality unknown. British Museum, No. 30832. Left valve and dorsal view. $\times \frac{7}{8}$.

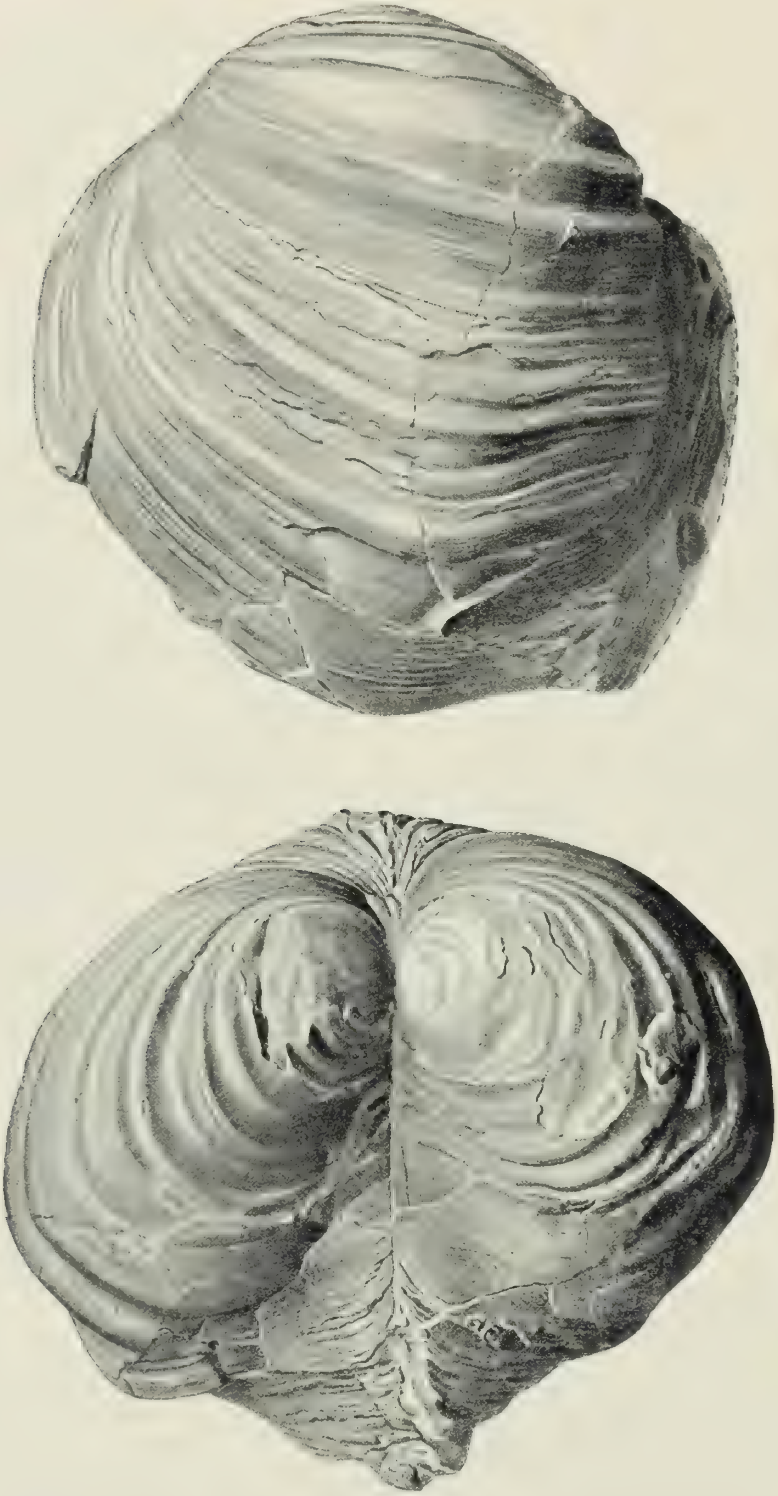


FIG. 49.—*Inoceramus inconstans*, sp. nov. Zone of *Actinocamax quadratus*, East Harnham, Salisbury. Dr. Blackmore's Collection. Left valve and dorsal view. Natural size.

Types.—The specimen figured by Mantell as *I. Brongniarti* var., from the Upper Chalk (probably zone of *Micraster cor-anguinum*) of Southeram (Lewes), and the one figured as *Inoceramus* sp. by the same author from Lewes, and *I. Lamarcki*, Sowerby (in Dixon), from the Chalk, Sussex (probably zone of *Terebratulina lata* of Malling), are in the British Museum, Nos. 5878, 4765, L20955 respectively.

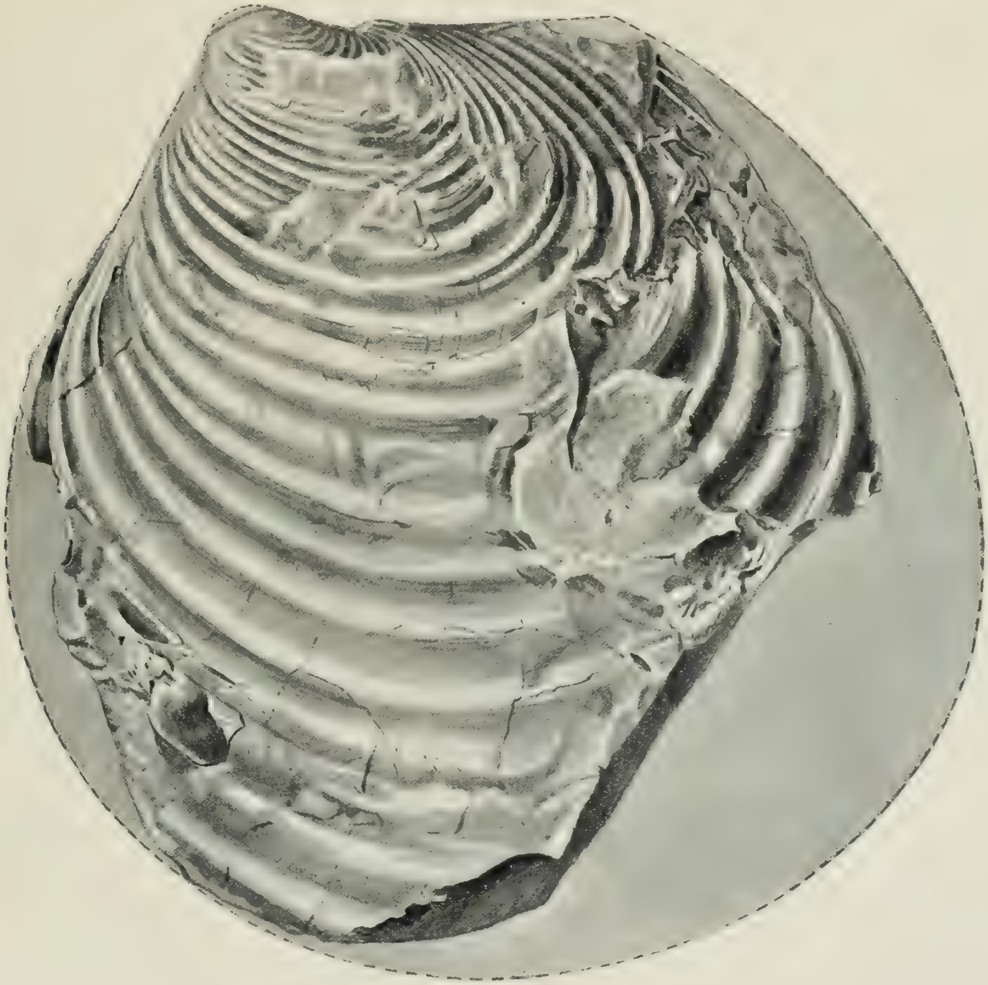


FIG. 50—*Inoceramus inconstans*, sp. nov. *var.* Senonian, Haldon. British Museum, No. L17380. Left valve. A large flat form resembling *I. cycloides*, Wegner. Compare with Fig. 46. × $\frac{7}{8}$.

Distribution.—Zone of *Holaster planus* of Twyford, Swaffham (Norfolk), and Strood. Zone of *Micraster cor-testudinarium* of Chatham, Guilford Colliery (Coldred near Dover), and Wharram (Yorkshire). Zone of *Micraster cor-anguinum* of Southeram (Lewes). Zone of *Actinocamax quadratus* of East Harnham (Salisbury) and Brighton. Zone of *Belemnitella mucronata* of Shide (Isle of Wight). Probably also in the zone of *Terebratulina lata*.

Inoceramus inconstans *var.* striatus, *Mantell*, 1822. Plate LI, fig. 5; Plate LII, fig. 1.

1822. Inoceramus striatus, *G. Mantell.* Foss. S. Downs, p. 217, pl. xxvii, fig. 5.
1828. — — *J. de C. Sowerby.* Min. Conch., vol. vi, p. 160, pl. dlxxxii, fig. 2.
1854. — — *J. Morris.* Cat. Brit. Foss., ed. 2, p. 170 (*partim*).

Non 1836. — — *A. Goldfuss.* Petref. Germ., vol. ii, p. 115, pl. cxii, fig. 2.
— 1841. — — *F. A. Römer.* Die Verstein. d. nord-deutsch. Kreidegeb., p. 62.
? — 1846. — — *A. E. Reuss.* Die Verstein. der böhm. Kreideformat., pt. 2, p. 25.
— 1846. — — *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 508, pl. ccccv.
— 1850. — — *d'Orbigny.* Prodr. de Pal., vol. ii, p. 168.
— 1852. — — *F. Römer.* Kreidebild. v. Texas, p. 60.
— 1863. — — *A. v. Strombeck.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xv, p. 108.
— 1863. — — *A. Kunth.* Ibid., vol. xv, p. 727.
— 1870. — — *F. Römer.* Geol. v. Oberschlesien, p. 340, pl. xxix, fig. 6.
— 1872–73. — — *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 1), p. 210, pl. xlvi, figs. 9—13; (ibid., pt. 2), p. 41, pl. xiii, figs. 1, 2, 9, 10.
— 1873. — — *Geinitz.* Neues Jahrb. für Min., etc., p. 7.
— 1877. — — *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat. ii, Weissenberg. u. Malnitz. Schicht., p. 129.
? — 1881. — — *J. Kiesow.* Schrift. nat. Gesellsch. Dantzig, vol. v, p. 413.
— 1885. — — *F. Nötling.* Die Fauna d. baltisch. Cenoman. (Palæont. Abhandl., vol. ii), p. 23, pl. iii, figs. 11, 12.
— 1893. — — *R. Michael.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xlv, p. 233.
— 1895. — — *E. Tiessen.* Ibid., vol. xlvii, p. 480.
— 1897. — — *H. Woods.* Quart. Journ. Geol. Soc., vol. liii, p. 381, pl. xxvii, fig. 13.
— 1911. — — *A. Fritsch.* Stud. im Gebiete böhm. Kreideformat. (Ergänzung zu Bd. I, Korycaner Schicht.), p. 42, fig. 190.

Remarks.—This variety, which is uncommon and of small size, is distinguished by the strongly inflated valves, the large angle between the hinge-line and the anterior border, the absence of folds, and the absence or indistinct character of the anterior flattened area and of the posterior ear.

Types.—The type, from the zone of *Micraster cor-anguinum* of Southeram, Lewes, is in the British Museum, No. 4768 (Plate LI, fig. 5). The specimen figured by Sowerby from the Upper Chalk (probably zone of *Holaster planus*) of Heytesbury is also in the British Museum, No. 43267.

Distribution.—Zone of *Holaster planus* of Stonehall siding near Dover, and Swaffham, Norfolk. Zone of *Micraster cor-anguinum* of Southeram. Upper Chalk (probably zone of *Holaster planus*), Heytesbury.

Inoceramus inconstans *var.* sarumensis, *var. nov.* Plate LII, figs. 2, 3.

A variety found in the zone of *Actinocamax quadratus* of East Harnham (Salisbury), Mottisfont, and West Meon (Hampshire), is distinguished by the umbones being more prominent and not terminal, by the regular convexity and equal size of the valves, the absence of the anterior flattened area, and the absence or indistinct character of the concentric folds. This variety is connected with typical forms of the species by some examples (Fig. 49) in which the early part of the shell is less convex and possesses distinct folds, but the umbones are not quite terminal and the anterior flattened area is not present. *I. inconstans* var. *sarumensis* appears to resemble *I. Brancoi*, Wegner,[1] of which good figures have not yet been published.

Inoceramus balticus, *Böhm*, 1907. Text-figs. 51—53.

1836. Inoceramus Cripsii, *A. Goldfuss.* Petref. Germ., vol. ii, p. 116, pl. cxii, fig. 4*b*. (Non *I. Crippsi*, Mantell, 1822).
1870. — — var. sulcata, *F. Römer.* Geol. v. Oberschles., p. 356, pl. xxxix, fig. 9.
1907. — balticus, *J. Böhm.* Zeitschr. d. deutsch. geol. Gesellsch., vol. lix, Monatsber., p. 113.
1909. — — *Böhm.* Subhercyn. Kreidemulde (Abhandl. d. k. preuss. geol. Landesanst; n.f. 56), p. 47, pl. xi, fig. 2*a*, pl. xii, fig. 1*a*.
1910. — — *J. Nowak.* Bull. Internat. Acad. Sci. Cracovie (1909), p. 875.

[1] 'Zeitschr. d. deutsch. geol. Gesellsch.,' vol. lvii (1905), p. 159, fig. 4.

Description.—Shell equivalve, very inequilateral, slightly or moderately convex, becoming very convex in old specimens, in which the later part of the shell grows either perpendicularly to or at an obtuse angle with the earlier part; posterior

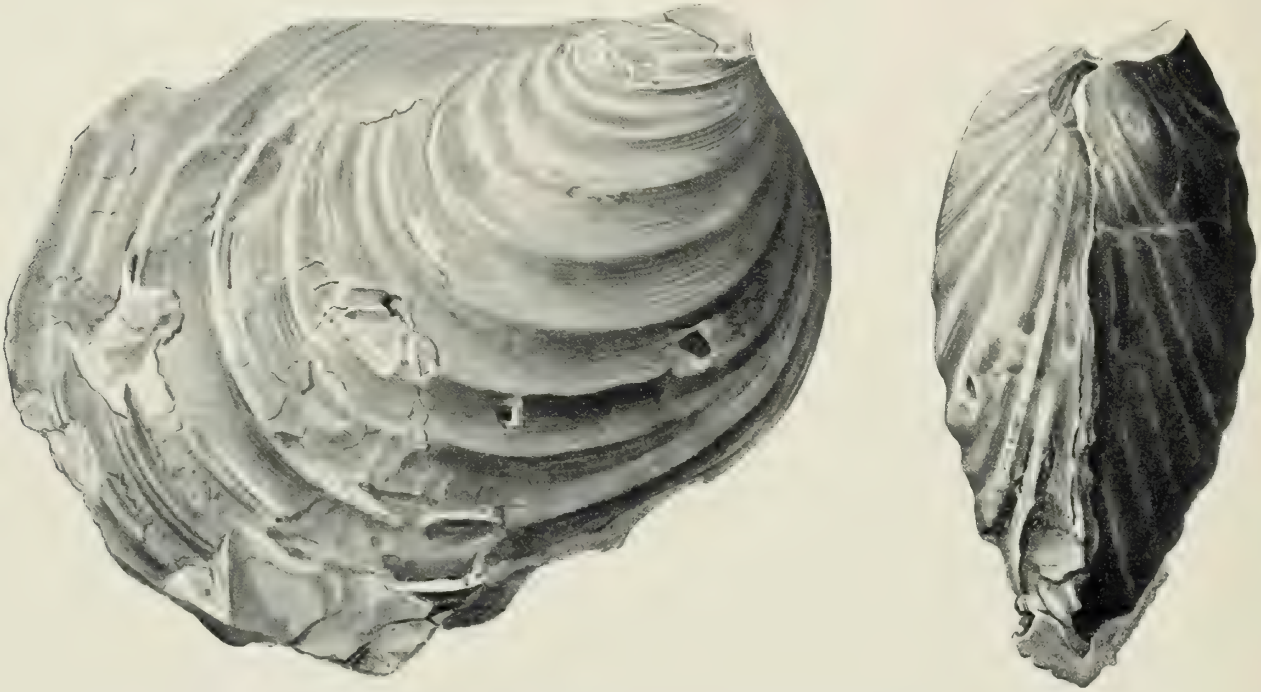


Fig. 51.—*Inoceramus balticus*, Böhm. Senonian, Worbarrow Bay, Dorset. British Museum, No. L22177. Flint cast. Right valve and anterior view. Natural size.

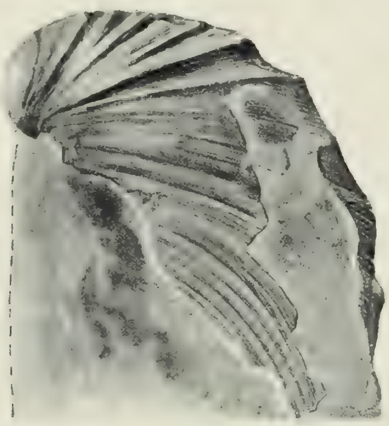


Fig. 52.—*Inoceramus balticus*, Böhm. Anterior view of specimen shown in Fig. 53. $\times \frac{3}{4}$.

and postero-dorsal parts compressed; length greater than height, the difference increasing with age. Anterior and ventral margins rounded; posterior margin forming an obtuse angle with the hinge. Hinge-line long. Umbones rather small, nearly terminal.

Concentric ribs strong, sharp, narrow, with a very unsymmetrical curvature; a few ribs may come off from the sides of other ribs; between the ribs are broad concave interspaces. On the marginal parts of old specimens ribs are absent.

Affinities.—*I. balticus* is closely allied to *I. inconstans*, from which it has

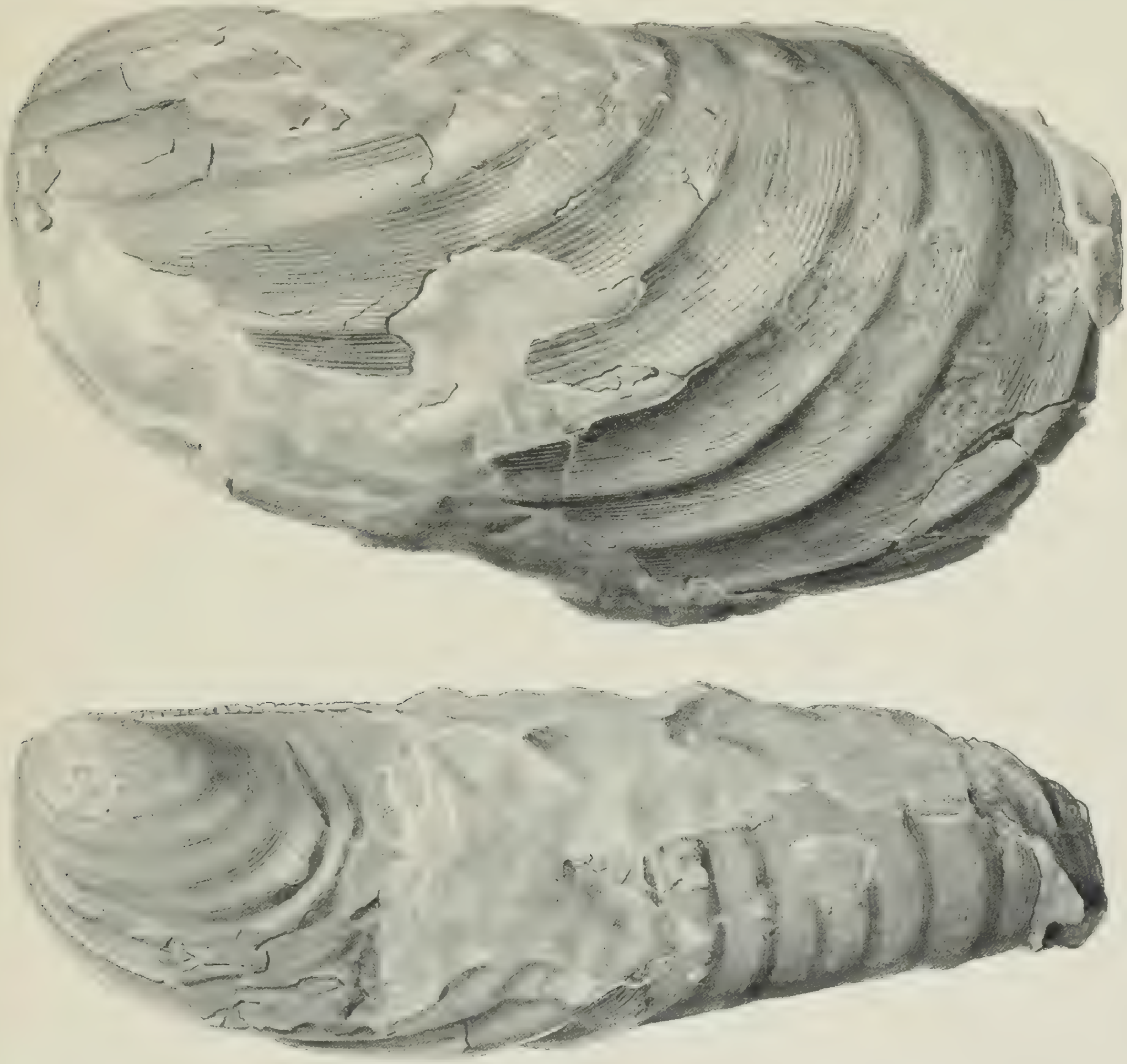


Fig. 53.—*Inoceramus balticus*, Böhm. Upper Chalk (probably zone of *Marsupites testudinarius*), Brighton. Museum of Practical Geology, No. 25509. Left valve and dorsal view. × $\frac{3}{4}$.

probably been derived; it differs from that species by its longer hinge and the longer shell, with the umbones not quite terminal. The length of duration of the slightly convex stage varies in the same way as in *I. inconstans*. The specimen of *I. inconstans* shown in Fig. 45 makes, on account of its longer hinge, some approach to *I. balticus*.[1]

[1] See also Böhm, loc. cit., pl. xii, fig. 1*a*.

I. regularis, d'Orbigny,[1] differs from *I. balticus* in the outline of the shell, in its uniform convexity, and in the broader and less sharp ribs.

Some of the forms from Gosau referred by Zittel to *I. Crippsi* resemble closely *I. balticus*.[2]

Type.—From the Lower *Quadratus* beds of Dülmen, in the Palæontological Institute of the University of Bonn.

Distribution.—Senonian of Haldon, and Worbarrow Bay (Dorset), and Brighton (probably zone of *Marsupites testudinarius*). Zone of *Actinocamax quadratus* of Mottisfont, Ropley (Hants), East Harnham (Salisbury), Mount Pleasant near Andover, Driffield, and Sewerby (Yorkshire). Zone of *Belemnitella mucronata* of Clarendon and Fareham (Hants), Alum Bay and Shide (Isle of Wight), and Norwich.

INOCERAMUS LOBATUS, *Goldfuss*, 1836. Text-figs. 54, 55.

1836.	INOCERAMUS LOBATUS,	*A. Goldfuss.*	Petref. Germ., vol. ii, p. 113, pl. cx, fig. 3.
1877.	— —	*C. Schlüter.*	Palæontographica, vol. xxiv, p. 275, pl. xxxix, figs. 1, 2.
1882.	— —	*H. Schröder.*	Zeitschr. d. deutsch. geol. Gesellsch., vol. xxxiv, p. 272.
? 1888.	— aff. LOBATUS,	*S. Nikitin.*	Les Vestiges Crét. dans la Russie Centrale (Mém. Comité Géol., vol. v, no. 2), p. 34, pl. v, fig. 12.
—	— LOBATUS,	*G. Müller.*	Jahrb. d. k. preuss. geol. Landesanst. fur. 1887, p. 415.
1889.	— —	*E. Holzapfel.*	Die Mollusk. Aachen. Kreide (Palæontographica, vol. xxxv), p. 223.
? 1894.	— aff. LOBATUS,	*K. Jimbō.*	Kreideformat. v. Hokkaidō (Palæont. Abhandl., vol. vi), p. 44, pl. viii, fig. 11.
1898.	— LOBATUS,	*G. Müller.*	Mollusk. Untersen. v. Braunschweig. u. Ilsede (Abhandl. d. k. preuss. geol. Landesanst., N.F., 25), p. 43, fig. 10.
? 1901.	— cf. LOBATUS,	*F. Sturm.*	Jahrb. d. k. preuss. geol. Landesanst. für 1900, vol. xxi, p. 93, pl. x, fig. 3.
1902.	— LOBATUS,	*A. Wollemann,*	Lüneburg. Kreide (Abhandl. d. k. preuss. geol. Landesanst., N.F., 37), p. 71.

[1] 'Pal. Franç. Terr. Cret.,' vol. iii (1846), p. 516, pl. ccccx.

[2] Compare also *I. Cripsi* var. *sulcata*, Römer, 'Kreidebild. v. Texas' (1852), p. 56, pl. vii, fig. 2, and *I. Cripsianus*, Stoliczka, 'Palæont. Indica, Cret. Fauna S. India,' vol. iii (1871), p. 405, pl. xxvii, figs. 1—3; pl. xxviii, fig. 2, and *I. crassus*, Petrascheck, 'Jahrb. d. k. k. geol. Reichsanst.,' vol. liii (1903), p. 164, pl. viii, fig. 4, and Andert, 'Inoceramen d. Kreibitz-Zittauer Sandsteingeb.' (1911), p. 46, pl. iii, fig. 4, pl. vi, figs. 1, 2.

1902.	Inoceramus lobatus		*J. P. J. Ravn.*	Mollusk. i Danmarks Kridtafl. I. Lamellibr., p. 103.
1905.	—	—	*T. Wegner.*	Zeitschr. d. deutsch. geol. Gesellsch., vol. lvii, p. 164, fig. 7, pl. x, figs. 1, 2, and text-fig. 7.
1906.	—	—	*G. Smoleński.*	Bull. Internat. Acad. Sci. Cracovie, p. 722, pl. xxvii, figs. 16–18.
1909.	—	—	*J. Nowak.*	Ibid (1909), p. 875.

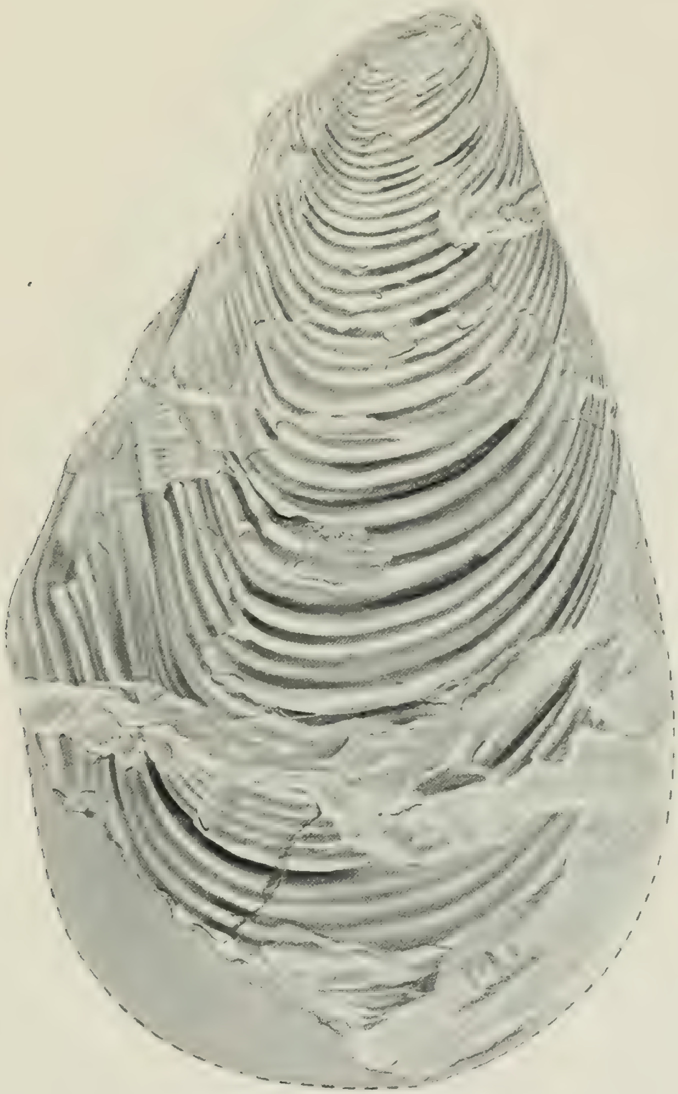


Fig. 54.—*Inoceramus lobatus*, Goldf. Zone of *Actinocamax quadratus*, East Leys, Yorkshire. British Museum, No. L23910. Internal cast of right valve; posterior wing missing. × $\frac{7}{8}$.

Description.—Shell very inequilateral, oblique, compressed, slightly convex—the anterior part more convex than the posterior part; much higher than long. Antero-dorsal marginal part sloping steeply. Ventral margin convex, with a

shallow sinus near the postero-ventral angle. Posterior margin nearly straight, somewhat oblique, forming an angle with the ventral margin. A broad shallow depression extends from behind the umbo to the postero-ventral sinuosity; posteriorly this depression is limited by an angular ridge. Behind the ridge is a

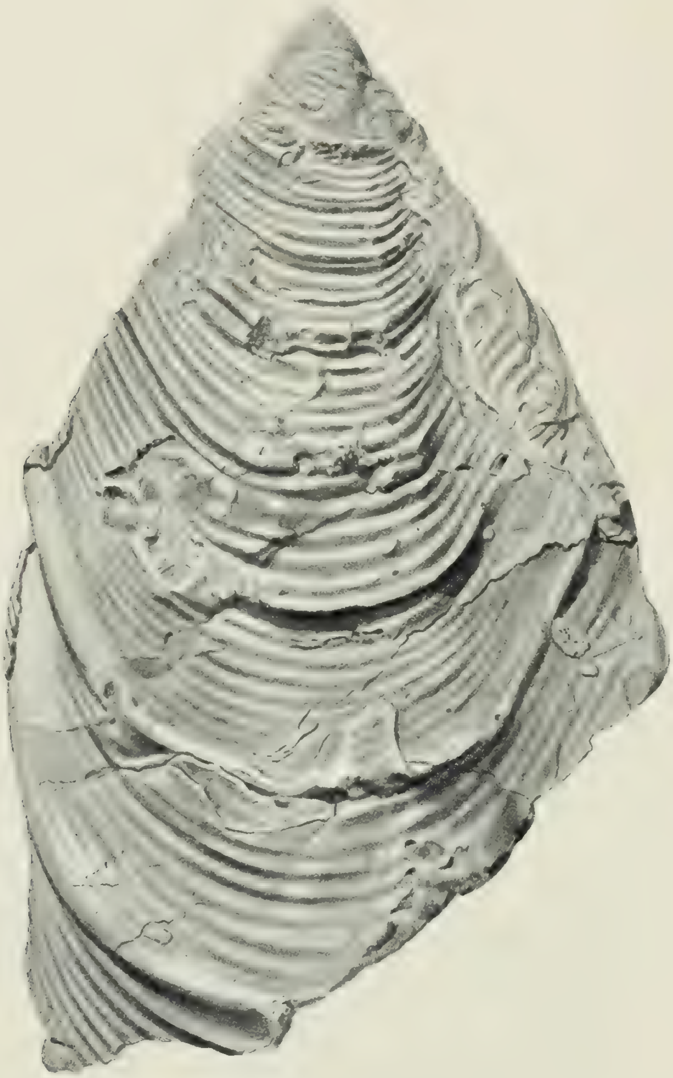


FIG. 55.—*Inoceramus lobatus*, Goldf. Zone of *Actinocamax quadratus*, Yorkshire. York Museum. Part of left valve. $\times \frac{7}{8}$.

flattened or slightly concave wing-like part which, owing to the thinness of the shell, is often not preserved. Umbones acute, near the anterior end.

Ornamentation consists of concentric ribs with an unsymmetrical curvature; in the posterior depression the ribs bend upwards, forming a sinuosity, and on the wing the ribs bend upwards and are less distinct than elsewhere. The concentric ribs are of two sizes; large ribs occur at intervals and between these are several smaller ribs.

Affinities.—*Inoceramus nasutus*, Wegner,[1] from the Senonian of Bossendorf and Dülmen, is allied to *I. lobatus*. See also *I. lingua*, *I. cardissoides*, and *I. tuberculatus* (below).

Remarks.—Only imperfect casts of this species have been seen, but it is abundant in Yorkshire. In North Germany this species occurs also in the zone of *Marsupites testudinarius*.

Type.—From the Lower Senonian of Quedlinburg.

Distribution.—Zone of *Actinocamax quadratus* of Sewerby, Bessingby and other localities in Yorkshire.

INOCERAMUS LINGUA, *Goldfuss*, 1836. Text-fig. 56.

1836. INOCERAMUS LINGUA, *A. Goldfuss.* Petref. Germ., vol. ii, p. 113, pl. cx, fig. 5.
1877. — — *C. Schlüter.* Palæontographica, vol. xxiv, p. 276, pl. xxxix, figs. 3, 4.
1898. — — *G. Müller.* Mollusk. Untersen. v. Braunschweig. u. Ilsede (Abhandl. d. k. preuss. geol. Landesanst., N.F., 25), p. 45, pl. v, fig. 8.
1899. — — *V. Popovici-Hatzeg.* Mém. Soc. géol de France, Paléont., vol. viii, pt. 3, p 7.
1902. — — *J. P. J. Ravn.* Mollusk. Danmarks Kridtafl., I. Lamellibr., p. 102.
1905. — — *T. Wegner.* Zeitschr. d. deutsch. geol. Gesellsch., vol. lvii, p. 168.
1909. — — *J. Nowak.* Bull. Internat. Acad. Sci. Cracovie, p. 875.

Remarks.—This species is closely allied to *I. lobatus*, Goldfuss, but the specimens at present available are not sufficiently perfect to enable me to make a close comparison. *I. lingua* appears to differ from *I. lobatus* in the absence of the ridge between the umbo and the postero-ventral angle, in the absence or indistinct character of the radial depression in front of the ridge, in the greater relative length of the shell, and in the ribs being either of uniform size or of two sizes less distinctly marked than in *I. lobatus*.

Type.—From the Senonian of Dülmen.

Distribution.—Upper Chalk of Birdsall, Yorkshire. Zone of *Belemnitella*

[1] 'Zeitschr. d. deutsch. geol. Gesellsch.,' vol. lvii (1905), p. 167, pl. x, fig. 3, text-fig. 8.

mucronata of Norwich. Recorded by Barrois from the zone of *Marsupites testudinarius* of Rottingdean.

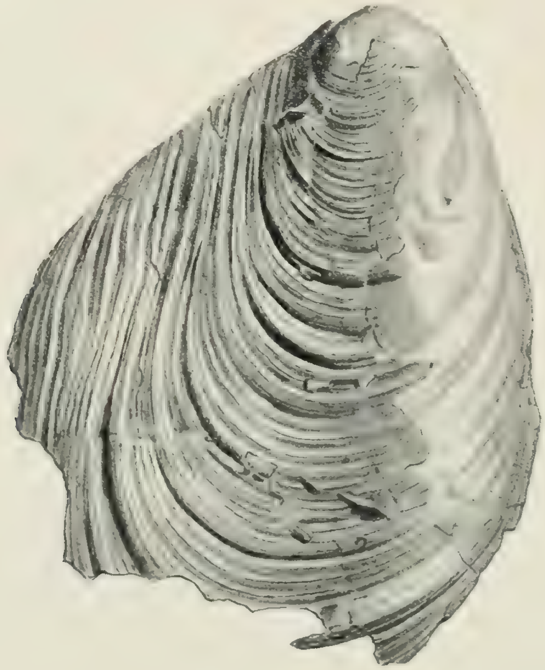


FIG. 56.—*Inoceramus lingua*, Goldf. Zone of *Belemnitella mucronata*, Norwich. British Museum, No. L20956. Part of right valve. Natural size.

INOCERAMUS CARDISSOIDES, *Goldfuss*, 1836. Text-figs. 57, 58.

1836. INOCERAMUS CARDISSOIDES, *A. Goldfuss*. Petref. Germ., vol. ii, p. 112, pl. cx, fig. 2.
1841. — LOBATUS var. β. CARDISSOIDES, *F. A. Römer*. Die Verstein. d. nord-deutsch. Kreidegeb., p. 63.
1876. — CARDISSOIDES, *D. Brauns*. Zeitschr. f. d. gesammt. Naturwiss., vol. xlvi, p. 377.
1877. — — *C. Schlüter*. Palæontographica, vol. xxiv, p. 274.
1888. — — *G. Müller*. Jahrb. d. k. preuss. geol. Landesanst. für 1887, p. 415.
1898. — — *G. Müller*. Mollusk. Untersen. v. Braunschweig u. Ilsede (Abhandl. d. k. preuss. geol. Landesanst., N.F., 25), p. 44, fig. 11.
1902. — — *A. Wollemann*. Lüneburg. Kreide (Ibid., 37), p. 71.
1905. — — *T. Wegner*. Zeitschr. d. deutsch. geol. Gesellsch., vol. lvii, p. 169.

Non 1882. Inoceramus cardissoides, *H. Schröder.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xxxiv, p. 271, pl. xvi, fig. 1.

Description.—Shell very inequilateral, oblique, moderately convex, with the anterior marginal part sloping rapidly. Height considerably greater than length.

Fig. 57.

Fig. 58.

Fig. 57.—*Inoceramus cardissoides*, Goldf. Upper Chalk (probably zone of *Actinocamax quadratus*), near Speeton. Sedgwick Museum. Left valve. Posterior wing missing. Natural size.
Fig. 58.—*Inoceramus cardissoides*, Goldf. Upper Chalk, probably Kent. British Museum, No. 98209. Part of left valve. Natural size.

Ventral margin convex; anterior margin slightly curved. A broad concave depression extends from behind the umbo to the postero-ventral extremity, and is limited posteriorly by a straight, sharp ridge, behind which is a wing-like part of the shell.

Ornamentation consists of strong, widely separated concentric ribs, with a steep ventral slope and a more gentle dorsal slope; in the interspaces are small concentric ribs, which are crossed by small radial ribs giving a more or less distinctly

tuberculate character to the larger concentric ribs. On the posterior part of the shell the concentric ribs bend sharply upwards.

Remarks.—Only two imperfect specimens of this species have been seen; it is closely allied to *I. lobatus* (p. 296), but differs in the presence of radial ribs, the greater development of the larger concentric ribs, and in the greater convexity of the valves.

Type.—From the Senonian of Quedlinburg.

Distribution.—Upper Chalk (probably zone of *Actinocamax quadratus*) near Speeton, and the south of England (probably Kent).

INOCERAMUS TUBERCULATUS, sp. nov. Plate LIV, fig. 8. Text-fig. 59.

1882. INOCERAMUS CARDISSOIDES, *H. Schröder.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xxxiv, p. 271, pl. xvi, fig. 1 (*Non* Goldfuss).

Description.—Shell very inequilateral, oblique, much higher than long; dorsal part moderately convex, ventral part only slightly convex. Umbones relatively small, nearly terminal. Antero-dorsal area flattened, nearly smooth. A rounded depression, separated from the posterior wing-like part, passes from the umbo to the postero-ventral extremity. Hinge-line forms less than a right angle with the anterior margin.

Ornamentation consists of numerous concentric ribs which, at a short distance from the umbo, are crossed by radial furrows, so that the ribs appear then to consist of rows of tubercles; on the sides of the shell the radial furrows, and consequently also the tubercles, are less distinct than on the middle of the shell.

Affinities.—This species is allied to *I. lobatus* and *I. cardissoides*, but differs in the greater development of the radial ribs, which give rise to a tuberculate type of ornamentation; also the stronger concentric ribs which occur in *I. cardissoides* are small or altogether wanting. The English specimens agree fairly closely with the example figured by Schröder as *I. cardissoides.*

Type.—In Dr. Rowe's Collection.

Distribution.—Upper Chalk (zone of *Actinocamax quadratus*) of Brighton, and Sewerby (Yorkshire).

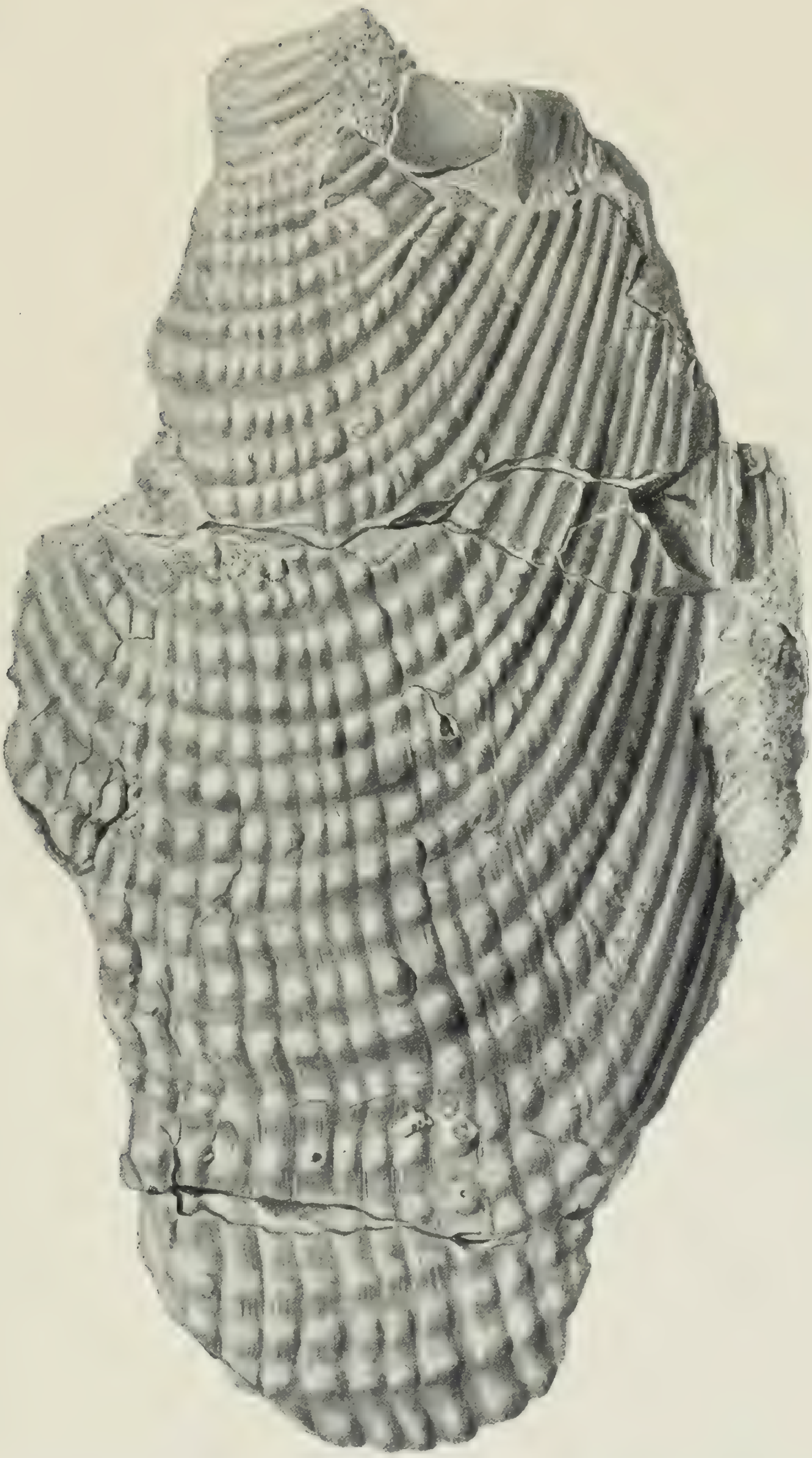


FIG. 59.—*Inoceramus tuberculatus*, sp. nov. Zone of *Actinocamax quadratus* of Sewerby, Yorkshire. Dr. A. W. Rowe's Collection. Part of right valve. Natural size.

INOCERAMUS UNDULATO-PLICATUS, *Römer*, 1852. Text-figs. 60, 61.

1852. INOCERAMUS UNDULATO-PLICATUS, *F. Römer*. Kreidebild. v. Texas, p. 59, pl. vii, fig. 1.
1865. — DIGITATUS, *F. A. Römer*. Palæontographica, vol. xiii, p. 196, pl. xxxii, fig. 6.
1873. — — *F. Schmidt*. Mém. Acad. Imp. Sci. de St. Pétersb., ser. 7, vol. xix, no. 3, p. 25 (*partim*), pl. v, figs. 10, 11; pl. vi, fig. 1, 2, 4, 6, 7; pl. vii; pl. viii, figs. 9—15.
1877. — UNDULATO-PLICATUS, *C. Schlüter*. Palæontographica, vol. xxiv, p. 270, pl. xxxviii, fig. 1.
1878. — — *C. Barrois*. Ann. Soc. géol. du Nord, vol. v, p. 475.
1894. — DIGITATUS, *K. Jimbō*. Palæont. Abhandl., vol. vi, p. 43, pl. viii, figs. 8—10.
1899. — SCHMIDTI, *R. Michael*. Jahrb. d. k. preuss. geol. Landesanst. für 1898, vol. xix, p. 162, figs. 1—4.

Description.—Shell ovate, much higher than long, very inequilateral; the early part of the shell of small or moderate convexity, the later part only slightly convex or nearly flat. Hinge-line forming more than a right angle with the anterior margin. Umbones terminal, small, curved anteriorly.

Ornamentation consists of concentric and radial ribs; the former are more distinct on the early part of the shell, the latter on the later part. The radial ribs curve outwards from a line between the umbo and the postero-ventral extremity; they have rounded summits, and are separated by broad shallow interspaces; a tubercle or rounded elevation may be developed where the concentric ribs cross the radial ribs.

Affinities.—This species is closely allied to *I. digitatus*, Schlüter (*non* Sowerby).

The fact that in some specimens the early part of the shell is ornamented with concentric folds only, and the radial ribs appear on the later parts, suggests that this species has been derived from one with concentric folds only, in a manner similar to that in which *I. sulcatus* has arisen from *I. concentricus* (see p. 268); the specimens at present available, however, do not enable us to trace the origin of *I. undulato-plicatus*, but it seems probable that it has descended from a flat variety of *I. inconstans*.

Forms from Vancouver Island with a similar type of ornamentation have been

referred to *I. undulato-plicatus* by Whiteaves,[1] but White[2] doubts the correctness of the identification. *I. diversus*, Stoliczka,[3] is another allied form.

Michael does not accept Schmidt's and Schlüter's identification of the specimens from Saghalien and North Germany with Römer's *I. undulato-plicatus*, but regards them as belonging to a distinct species for which he proposes the name *I. Schmidti*. He, however, regards *I. diversus*, Stoliczka, as an example of

Fig. 60.

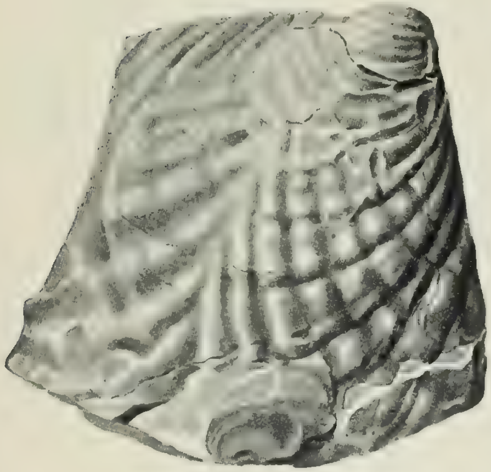


Fig. 61.

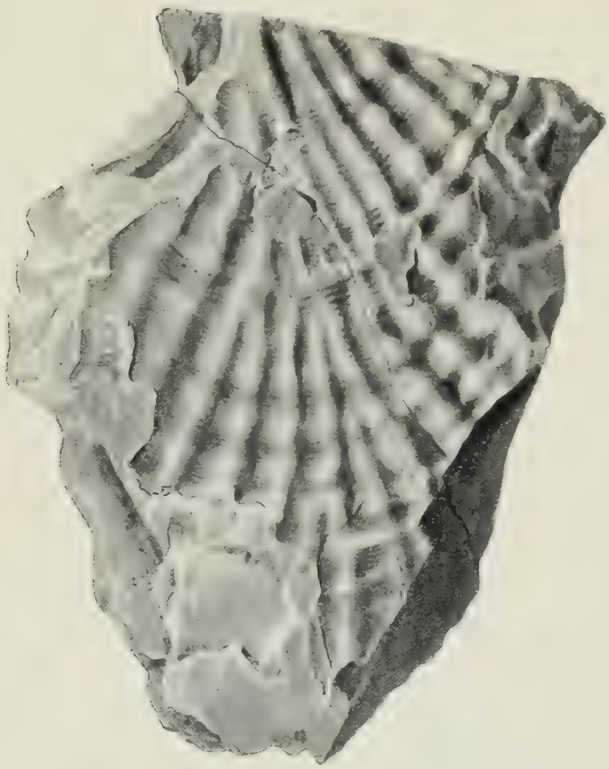


Fig. 60.—*Inoceramus undulato-plicatus*, Röm. Senonian, Haldon. British Museum, No. L17371. Flint cast of part of right valve. Natural size.

Fig. 61.—*Inoceramus undulato-plicatus*, Röm. Senonian, Haldon. British Museum, No. L17369. × $\frac{7}{8}$.

this species, consequently it was unnecessary to introduce a new name. The English specimens show a good deal of variation, and after comparing them with Römer's and other figures I do not feel able to accept Michael's view.

Type.—From the Chalk of Texas.

Distribution.—Senonian of Haldon.

[1] 'Geol. Surv. Canada, Mesoz. Foss.,' vol. i (1879), p. 168, pl. xx, fig. 2, and *I. digitatus* (ibid., 1903), p. 395; also 'Trans. Roy. Soc. Canada,' ser. 2, vol. i (1895), p. 121.

[2] 'Bull. U. S. Geol. Surv.,' no. 51 (1889), p. 37.

[3] 'Palæont. Indica, Cret. Fauna S. India,' vol. iii (1871), p. 407, pl. xxvii, fig. 6.

Fig. 62.—*Inoceramus undulato-plicatus* var. *digitatus*, Schlüt. Zone of *Micraster cor-anguinum*, Snowdown Colliery Shaft, Nonington, near Dover. British Museum, No. L20844 (discovered and presented by Dr. Malcolm Burr). Cast of part of left valve. × ¾.

INOCERAMUS UNDULATO-PLICATUS *var.* DIGITATUS, *Schlüter*, 1877. Text-fig. 62.

1873. INOCERAMUS DIGITATUS, *F. Schmidt.* Mém. Acad. Imp. Sci. de St. Pétersb., ser. 7, vol. xix, no. 3, p. 25 (*partim*), pl. vi, figs. 3, 5.
1877. — — *C. Schlüter.* Palæontographica, vol. xxiv, p. 267, pl. xxxvi.
1878. — — *C. Barrois.* Ann. Soc. géol. du Nord, vol. v, p. 475.
1902. — — *A. Wollemann.* Lüneburg. Kreide (Abhandl. d. k. preuss. geol. Landesanst., N.F., 37), p. 70.

Remarks.—As was pointed out by Schlüter, this form is very closely allied to, and perhaps not separable from, *I. undulato-plicatus;* it differs from the latter mainly in that the posterior ribs are stronger and fewer in number than the anterior ribs, but the early parts of the shell are very similar in the two forms. Until more specimens have been obtained the exact relationships of the two forms cannot be determined, and for the present it seems best to regard *I. digitatus* of Schlüter (*non* Sowerby) as a variety of *I. undulato-plicatus.*

Distribution.—Zone of *Micraster cor-anguinum* of Charlton, Snowdown Colliery Shaft, Nonington near Dover, Preston near Faversham, and Salisbury. Zone of *Actinocamax quadratus* of Salisbury.

INOCERAMUS LAMARCKI, *Parkinson*, 1819. Plate LII, figs. 4—6; Plate LIII, figs. 1—7. Text-figs. 63—85.

1768. OSTREOPINNITES, *J. E. I. Walch.* Naturgeschichte d. Verstein., vol. ii, p. 142, pl. DI**, figs. 1—5.
1819. INOCERAMUS LAMARCKII, *J. Parkinson.* Trans. Geol. Soc., ser. 1, vol. v, p. 55, pl. i, fig. 3.
1822. — CUVIERI, *J. Sowerby.* Trans. Linn. Soc., vol. xiii, p. 453, pl. xxv.
— — LAMARCKII, *G. Mantell.* Foss. S. Downs, p. 214, pl. xxvii, fig. 1.
— — CUVIERI, *Mantell.* Ibid., p. 213, pl. xxvii, fig. 4, pl. xxviii, figs. 1, 4.
— — BRONGNIARTI, *Mantell.* Ibid., p. 214, pl. xxvii, fig. 8.
— — WEBSTERI, *Mantell.* Ibid., p. 216, pl. xxvii, fig. 2.
— — UNDULATUS, *Mantell.* Ibid., p. 217, pl. xxvii, fig. 6.
— — LATUS, *Mantell.* Ibid., p. 216, pl. xxvii, fig. 10.
— CATILLUS CUVIERI, *A. Brongniart.* In Cuvier's Ossemens Foss., vol. ii, p. 601, pl. iv., fig. 10.

1823. INOCERAMUS CUVIERI, *J. de C. Sowerby.* Min. Conch., vol. v, p. 59, pl. ccccxli, fig. 1.
— — BRONGNIARTI, *Sowerby.* Ibid., vol. v, p. 60, pl. ccccxli, figs. 2, 3.
1836. — LAMARCKII, *A. Goldfuss.* Petref. Germ., vol. ii., p. 114, pl. cxi, fig. 2.
— — CUVIERI, *Goldfuss.* Ibid., vol. ii, p. 114, pl. cxi, fig. 1.
— — BRONGNIARTI, *Goldfuss.* Ibid., vol. ii, p. 115, pl. cxi, fig. 3.
— — STRIATUS, *Goldfuss.* Ibid., p. 115, pl. cxii, fig. 2.
1837. CATILLUS LAMARCKI, *F. Dujardin.* Mém. Soc. géol. de France, vol. ii, p. 225.
1837. — CUVIERI, *Dujardin.* Ibid., vol. ii, p. 225.
— INOCERAMUS BRONGNIARTI, *W. Hisinger.* Lethæa Suecica, p. 56, pl. xvii, fig. 11.
— — CUVIERI, *Hisinger.* Ibid., p. 56, pl. xvii, fig. 10.
1841. — LAMARCKII, *F. A. Römer.* Die Verstein. d. nord-deutsch. Kreidegeb., p. 62.
— — CUVIERI, *Römer.* Ibid., p. 62.
— — BRONGNIARTI, *Römer.* Ibid., p. 61.
? — — UNDULATUS, *Römer.* Ibid., p. 63, pl. viii, fig. 12.
1846. — CUVIERI, *A. E. Reuss.* Die Verstein. der böhm. Kreideformat., pt. 2, p. 25.
— — BRONGNIARTI, *Reuss.* Ibid., pt. 2, p. 24.
? — CUVIERI, *A. Leymerie.* Statist. géol. min. de l'Aube, Atlas, pl. iv, fig. 7.
— — ANNULATUS, *Leymerie.* Ibid., pl. iv, fig. 4.
— — CUVIERI, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 520.
1850. — BRONGNIARTI, *H. B. Geinitz.* Das Quadersandst. oder Kreidegeb. in Deutschland, p. 172.
? — — CUVIERI, *A. d'Orbigny.* Prodr. de Pal., vol. ii, p. 250.
1850. — — *R. Kner.* Kreidemerg. v. Lemberg (Haidinger's Naturwiss. Abhandl., vol. iii, pt. 2), p. 28.
1854. — LAMARCKII, *J. Morris.* Cat. Brit. Foss., ed. 2, p. 169.
— — CUVIERI, *Morris.* Ibid., p. 169 (*partim*).
— — BRONGNIARTII, *Morris.* Ibid., p. 169.
— — UNDULATUS, *Morris.* Ibid., p. 170.
— — WEBSTERII, *Morris.* Ibid., p. 170.
1863. — CUVIERI, *A. v. Strombeck.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xv, p. 124.
— — BRONGNIARTI, *Strombeck.* Ibid., vol. xv, p. 121.
— — — *R. Drescher.* Ibid., vol. xv, p. 352.
?1869. — LAMARKI, *E. Favre.* Moll. Foss. de la Craie de Lemberg, p. 134.
1870. INOCERAMUS BRONGNIARTI, *F. Römer.* Geol. v. Oberschles., p. 316, pl. xxxiv, fig. 13.

1872. INOCERAMUS BRONGNIARTI, *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 2), p. 43, pl. xi, figs. 3—10, pl. xiii, fig. 3.
? — — CUVIERI, *Geinitz.* Ibid., p. 48 (*partim*), pl. xiii, fig. 8.
1873. — BRONGNIARTI, *Geinitz.* Neues Jahrb. für Min., etc., p. 10.
? — — CUVIERI, *Geinitz.* Ibid., p. 15.
? — — LAMARCKI, *Geinitz.* Ibid., p. 18.
? 1875. — LATUS, *C. Décocq.* Assoc. Franç. Avanc. Sci. (Lille, 1874), p. 369.
1877. — CUVIERI, *C. Schlüter.* Palæontographica, vol. xxiv, p. 266.
— — BRONGNIARTI, *C. Schlüter.* Ibid., vol. xxiv, p. 263.
— — — *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat., ii, Weissenberg. u. Malnitz. Schicht., p. 130, fig. 111.
1878. — — *G. Behrens.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xxx, p. 256.
? — — UNDULATUS, *C. Barrois.* Ann. Soc. géol. du Nord, vol. v, p. 407.
1881. — (MYTILITES) PROBLEMATICUS, *R. Etheridge*, in Penning and Jukes-Browne, Geol. Cambridge, p. 143, pl. iii, figs. 9, 10, 11.
? 1883. — BRONGNIARTI, *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat., iii. Iserschicht., p. 110, fig. 80.
1888. — CUVIERI, *A. Peron.* Hist. Terr. Craie S.E. Bassin Anglo-Parisien, p. 156.
— — BRONGNIARTI, *Peron.* Ibid., p. 157.
— — UNDULATUS, *Peron.* Ibid., p. 157.
? 1889. — CUVIERI, *A. Fritsch.* Stud. im Gebiete der böhm. Kreideformat., iv, Teplitz. Schicht., p. 82, fig. 74.
? — — BRONGNIARTI, *Fritsch.* Ibid., p. 81, fig. 72.
1892. — CUVIERI, *E. Stolley.* Die Kreide Schleswig-Holsteins (Mittheil. a. d. min. Institut Kiel, vol. i.), p. 241.
1893. — BRONGNIARTI, *R. Michael.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xlv, p. 242.
1897. — STRIATUS, *H. Woods.* Quart. Journ. Geol. Soc., vol. liii, p. 381, pl. xxvii, fig. 13.
— — CUVIERI, *R. Leonhard.* Palæontographica, vol. xliv, p. 49.
— — BRONGNIARTI, *Leonhard.* Ibid., vol. xliv, p. 47.
1899. — — *J. Simionescu.* Fauna Cret. Super. Ürmös, p. 27.
? — — CUVIERI, *Simionescu.* Ibid., p. 27, pl. ii, figs. 8, 9.
? 1901. — aff. CUVIERI, *H. Imkeller.* Palæontographica, vol. xlviii, p. 34.

1901. INOCERAMUS CUVIERI, *F. Sturm.* Jahrb. d. k. preuss. geol. Landesanst., für 1900, vol. xxi, p. 92, pl. x, fig. 1.
1902. — — *A. Wollemann.* Lüneburg. Kreide (Abhandl. d. k. preuss. geol. Landesanst., N.F., 37), p. 67.
— — BRONGNIARTI, *Wollemann.* Ibid., p. 66.
1903. — — *W. Petrascheck.* Jahrb. d. k. geol. Reichsanst., vol. liii, p. 161.
— — CUVIERI, *Petrascheck.* Ibid., p. 162.
1904. — LATUS, *E. T. Newton* and *A. J. Jukes-Browne.* In Jukes-Browne, Cret. Rocks of Britain, vol. iii, p. 448 (*partim*).
— — CORDIFORMIS, *C. Airaghi.* Boll. Soc. geol. Italiana, vol. xxiii, p. 189, pl. iv, figs. 6—9.
1908. — CUVIERI, *A. Stojanoff.* Ann. géol. min. Russie, vol. x, p. 121.
1909. — — *J. Nowak.* Bull. Internat. Acad. Sci. Cracovie, p. 875.
1911. — LATUS, *W. Rogala.* Ibid. (1911), p. 172, pl. iv, figs. 9, 10.
— — KOEGLERI, *H. Andert.* Inoceramen d. Kreibitz-Zittauer Sandsteingeb., p. 57, pl. v, fig. 6, pl. i, fig. 6.

Non 1827. — CUVIERI, *S. Nilsson.* Petrific. Suecana, p. 19.
? — — CATILLUS BRONGNIARTI, *Nilsson.* Ibid., p. 19.
— 1832. INOCERAMUS UNDULATUS, *C. H. v. Zieten.* Verstein. Württembergs, p. 96, pl. lxxii, fig. 7.
— 1846. — LAMARCKII, *A. d'Orbigny.* Pal. Franç. Terr. Crét., vol. iii, p. 518, pl. ccccxii, figs. 1—3.
? — 1847. — CUVIERI, *J. Müller.* Petref. der Aachen. Kreidef., pt. 1, p. 31.
? — — — BRONGNIARTI, *Müller.* Ibid., pt. 1, p. 30.
— 1850. — LAMARCKII, *J. de C. Sowerby.* In *F. Dixon,* Geol. Sussex, p. 355 (p. 385, ed. 2), pl. xxviii, fig. 29 (= *I. inconstans*).
— 1866. — LAMARCKI, *K. A. Zittel.* Bivalv. d. Gosaugeb. (Denkschr. d. k. Akad. d. Wissensch. Wien, Math.-nat. Cl., vol. xxiv), pt. 2, p. 99 [23], pl. xv, fig. 6.
— 1872. — — *H. B. Geinitz.* Das Elbthalgeb. in Sachsen (Palæontographica, vol. xx, pt. 2), p. 50, pl. xiv, fig. 1 (fig. 4 = *saxonicus,* Petrascheck).
— — — CUVIERI, *Geinitz.* Ibid., p. 48, pl. xiii, figs. 6, 7.
? — 1872—3. — STRIATUS, *Geinitz.* Ibid., pt. 1, p. 210, pl. xlvi, figs. 9—13; pt. 2, p. 41, pl. xiii, figs. 1, 2, 9, 10.
— 1899. — UNDULATUS, *J. Simionescu.* Fauna Cret. super. Ürmös, p. 26, pl. iii, fig. 2.
— 1904. — BRONGNIARTII, *C. Airaghi.* Boll. Soc. geol. Italiana, vol. xxiii, p. 192, pl. iv, figs. 3—5.
— 1911. — CUVIERI, *H. Andert.* Inoceramen d. Kreibitz-Zittauer Sandsteingeb., p. 44, pl. ii, fig. 2.

Description.—Shell inequivalve, very inequilateral, of slight, moderate or considerable convexity, sometimes inflated. Height greater than length. Hinge-line of variable length in proportion to the height of the shell, forming more than a right-angle with the anterior margin. Umbones terminal, curved inwards and more or less forwards; the left umbo more prominent than the right. Anterior marginal part of valves flattened, more or less nearly perpendicular to the plane of the valves, either limited by a sharp edge from the flanks or without a definite boundary. Anterior ear developed in some flat varieties.

The concentric folds may be absent, indistinct, or moderately or strongly developed, with the dorsal and ventral slopes similar or with the ventral slope steeper than the dorsal. Usually the folds are regular, but are not continued on to the posterior ear. The curvature of the folds is often nearly symmetrical; its convexity on the convex and on some of the flat forms is small, but is greater on the flat forms with a relatively short hinge. The growth-lines are distinct and variable in number, and are sinuous where they pass on to the posterior ear.

Remarks.—The forms included in this species show a great amount of variation, and seem in that respect comparable with some species of *Micraster* and *Echinocorys*. Several of the varieties have been described as distinct species, but the study of a large series of specimens has shown so many intermediate forms that one can only regard the varieties as modifications of a very plastic species. The features in which variation is most marked are the convexity of the valves, the number, strength, and curvature of the concentric folds, the distance between the growth-lines, the size and distinctness of the posterior ear, and the height of the shell.

Some forms of this species are only slightly convex (Plate LIII, fig. 7, Text-figs. 73—83), so that in large specimens considerable portions of the shell approach flatness. In other forms the valves are moderately or considerably convex, and sometimes inflated (Plate LII, figs. 4, 5, Text-figs. 63—68). The amount of convexity may remain nearly uniform throughout the growth of the shell, or the earlier part may be only slightly convex and the later part very convex—in such cases the early part resembles the adult shell of the large flat varieties (Figs. 64, 65). The two valves may be of nearly equal convexity (Plate LII, fig. 5), or the left valve may be very convex whilst the right valve is only slightly convex (Plate LII, fig. 6).

The concentric folds vary in strength, number, form, curvature and regularity. In the majority of cases the folds are prominent and form strong ridges (Figs. 68, 69, 78, 82, 84), but they may become only gentle undulations (Figs. 74, 77, 81), and are sometimes indistinct or absent (Figs. 73, 75, 76, 79). The dorsal and ventral surfaces of the folds may slope equally, or the ventral slope may be steeper than the dorsal, giving a step-like appearance. The crest of the fold is

Fig. 63.—*Inoceramus Lamarcki*, Park. The type. Upper Chalk (probably zone of *Micraster cor-anguinum*), near Dover. British Museum, No. L9801. Left valve and dorsal view. Part of the posterior ear is concealed by flint. Natural size.

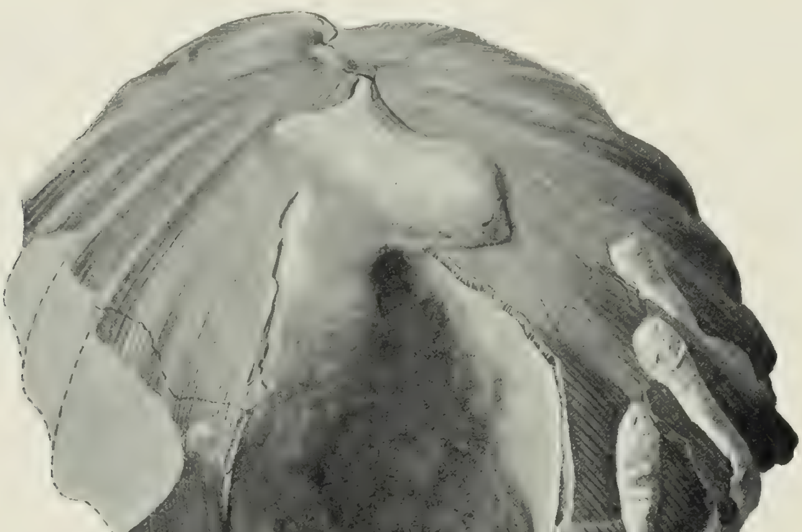


Fig. 64.—*Inoceramus Lamarcki*, Park. Anterior view of specimen shown in Fig. 65. $\times \frac{7}{8}$.

Fig. 65.

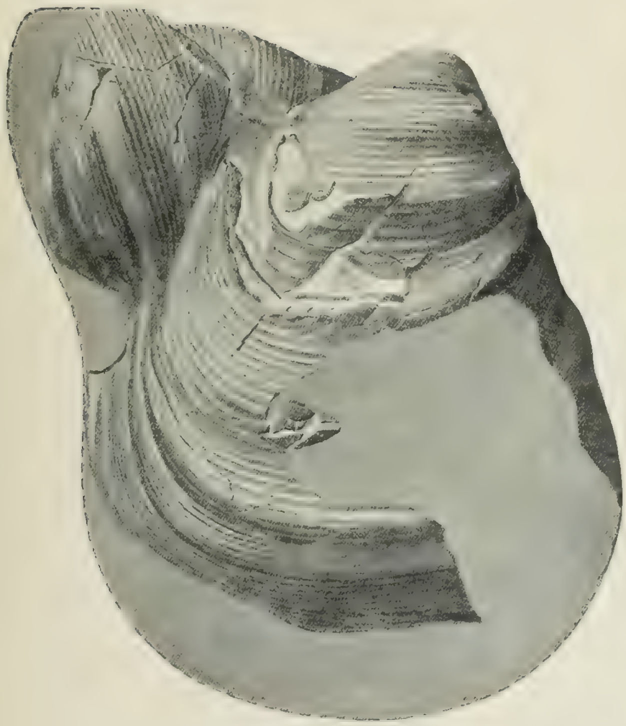


Fig. 67.

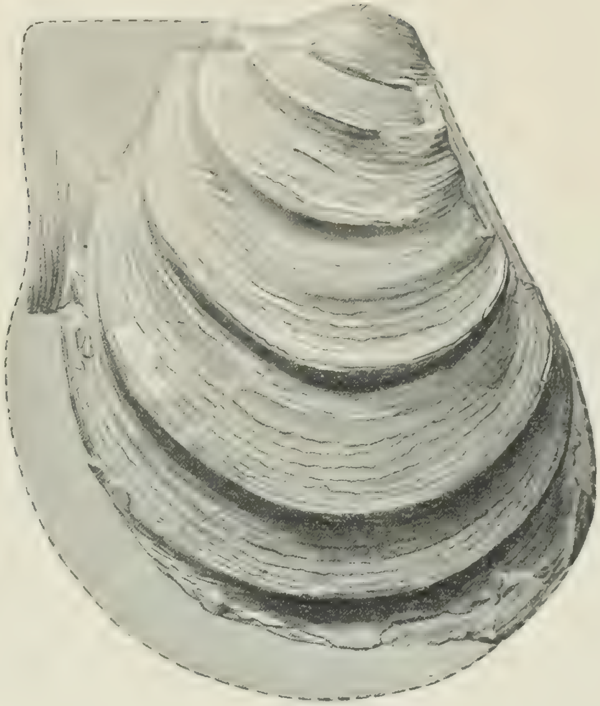


Fig. 65.—*Inoceramus Lamarcki*, Park. Upper Chalk (probably zone of *Holaster planus*), Swaffham, Norfolk. Norwich Museum, No. 3354. Right valve. × $\frac{7}{8}$.

Fig. 67.—*Inoceramus Lamarcki*, Park. Upper Chalk (zone of *Holaster planus*), Newmarket. Sedgwick Museum, Cambridge. Right valve. Natural size.

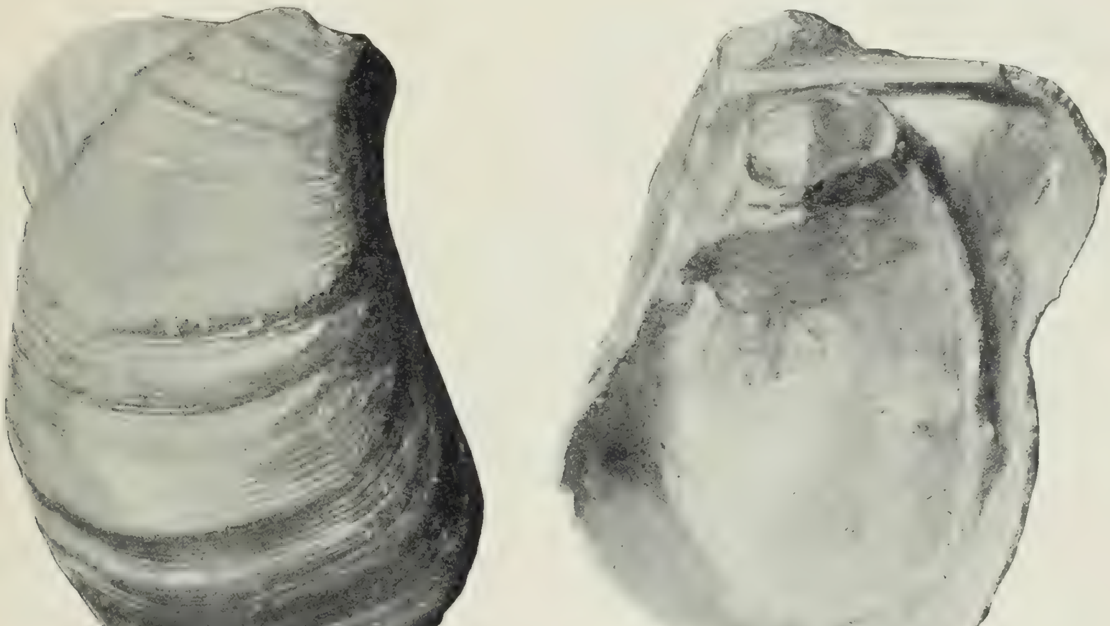


Fig. 66.—*Inoceramus Lamarcki*, Park. The original of *I. Lamarcki*, Mantell, 'Foss. S. Downs,' p. 214, pl. xxvii, fig. 1. Middle Chalk (probably zone of *Terebratulina lata*), near Lewes (probably Malling). British Museum, No. 4753. Right valve. Natural size.

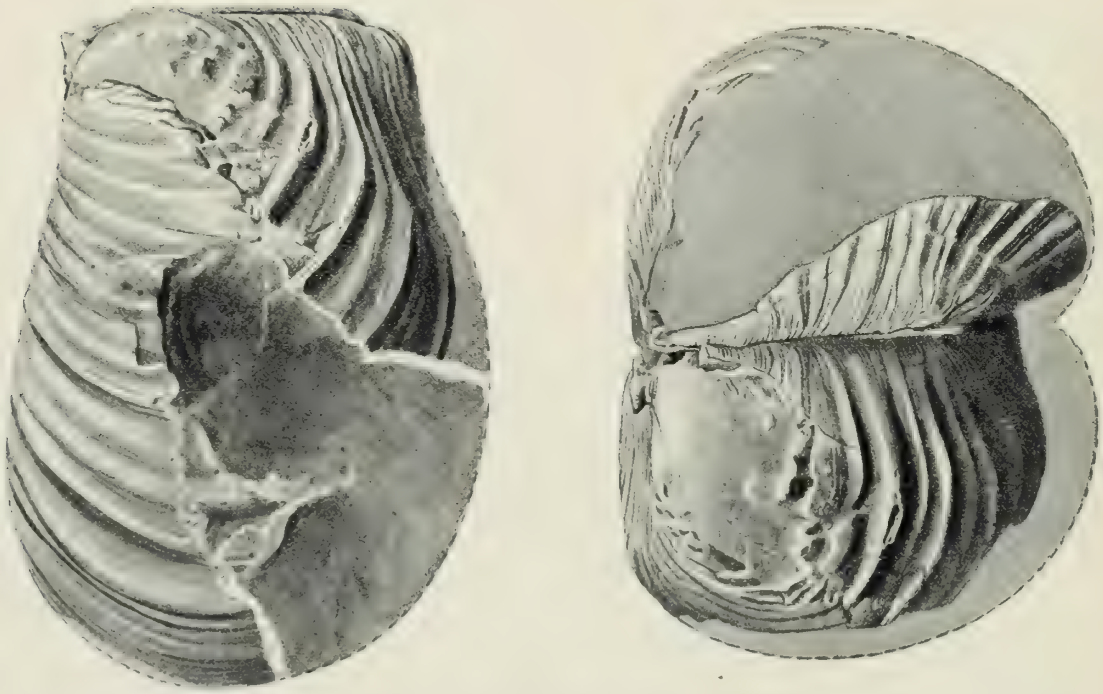


Fig. 68.—*Inoceramus Lamarcki*, Park. The type of *I. Brongniarti*, Mantell, 'Foss. S. Downs,' p. 214, pl. xxvii, fig. 8. From Lewes or Brighton, probably zone of *Micraster cor-anguinum*. British Museum, No. 4751. Left valve and dorsal view. Natural size.

Fig. 69.—*Inoceramus Lamarcki*, Park. The original of *I. Cuvieri*, Mantell, 'Foss. S. Downs,' p. 213, pl. xxviii, fig. 4. Zone of *Micraster cor-anguinum*, Southeram. British Museum, No. L22094. $\times \frac{7}{8}$.

Fig. 70.

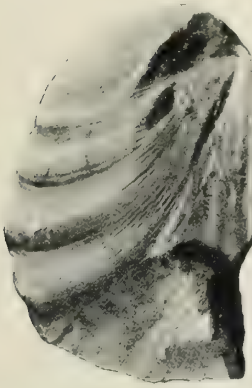


Fig. 71.

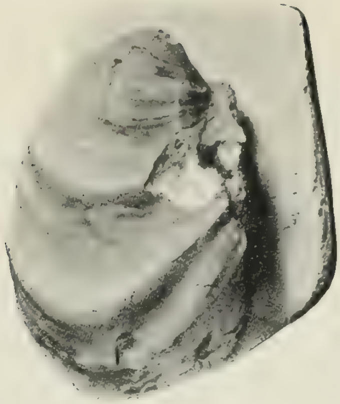


Fig. 70.—*Inoceramus Lamarcki*, Park. The original of *I. Brongniarti*, Sowerby, 'Min. Conch.,' vol. v, p. 60, pl. ccccxli, fig. 2. Chalk. Locality and horizon unknown. British Museum, No. 43265. Right valve. Natural size.

Fig. 71.—*Inoceramus Lamarcki* var. *Websteri*, Mant. The type of *I. Websteri*, Mantell, 'Foss. S. Downs,' p. 216, pl. xxvii, fig. 2. Upper Chalk (probably zone of *Micraster cor-testudinarium*), South Street, Lewes. British Museum, No. 4759. Left valve. Natural size.

Fig. 73.

Fig. 72.

Fig. 72.—*Inoceramus Lamarcki* var. *Websteri*, Mant. Upper Chalk, Swaffham, Norfolk. Norwich Museum, No. 3298. Left valve and anterior view. Natural size.

Fig. 73.—*Inoceramus Lamarcki* var. *Cuvieri*, Sow. The type of *Inoceramus Cuvieri*, Sowerby, 'Trans. Linn. Soc.,' vol. xiii (1822), p. 453, pl. xxv, figs. 2, 3, and 'Min. Conch.,' vol. v (1823), p. 59, pl. ccccxli, fig. 1. Middle Chalk (zone of *Terebratulina lata*), Royston. British Museum, No. 43264. Left valve. Natural size.

usually rounded, but in one variety (*Websteri*, Mantell, Plate LIII, figs. 1, 2, Text-figs. 71, 72) it possesses a sharp edge. When the folds are absent the growth-rings become more regular. The curvature of the folds is usually small in the more convex specimens, but often greater in the less convex forms. The curvature is often nearly symmetrical, but when the posterior ear is indistinctly limited it tends to become unsymmetrical.

The degree of development of the posterior ear varies considerably. In some forms it is only indistinctly limited (Plate LIII, fig. 7, Text-fig. 68), and then the

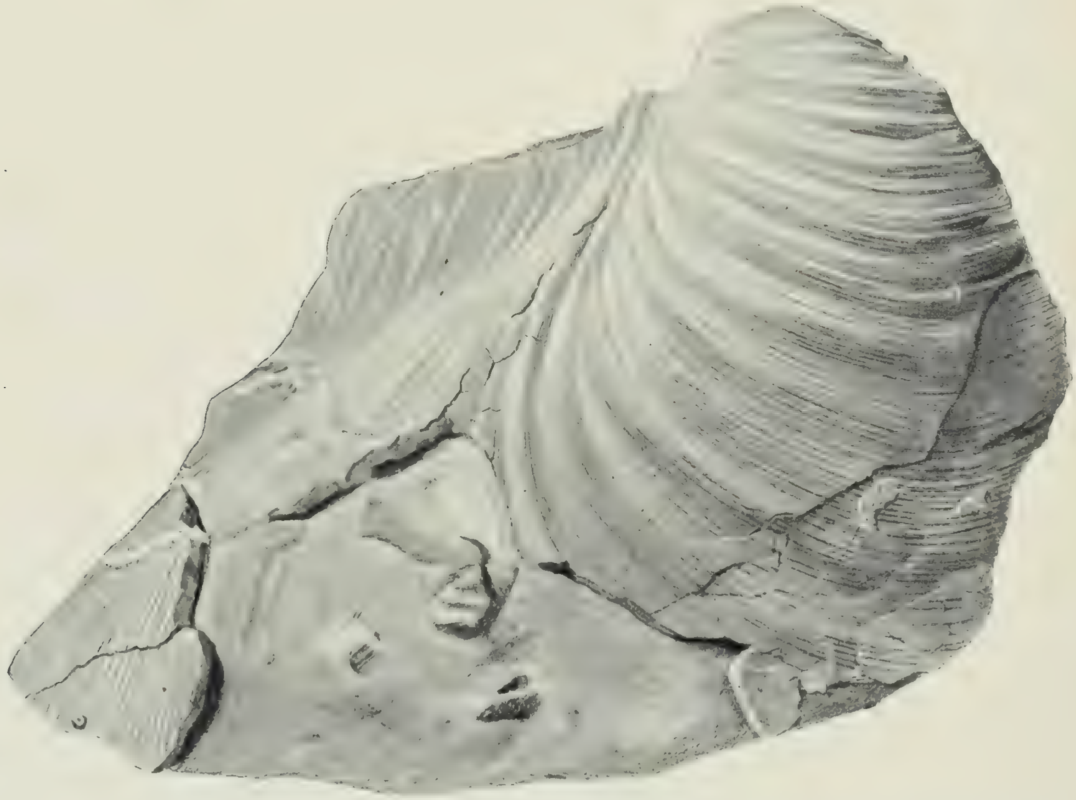


Fig. 74.—*Inoceramus Lamarcki* var. *Cuvieri*, Sow. Upper Chalk (zone of *Micraster cor-anguinum*), Camp Hill, near Salisbury. Dr. Blackmore's Collection. Portion of a large left valve; posterior and ventral parts missing. × $\frac{7}{8}$.

folds and growth-lines are continued with but little alteration in curvature on to the ear. In other cases the ear is larger and more or less distinctly limited from the rest of the valve (Plate LII, fig. 4, Text-figs. 63, 65, 66, 79, 81, 82); in such cases the folds and growth-lines bend inwards at the limit, and the umbonal part of the valve is often narrower and more acute. In a few large, flat forms, an anterior ear is developed (Fig. 74).

The anterior flattened area varies in size and in the distinctness of its boundary. It may be nearly perpendicular to the plane between the valves (Fig. 81), or may be slightly concave (Figs. 63, 66, 79), or slope outwards (Figs.

74, 79). In some varieties the area forms a sharp edge with the sides of the valve (Fig. 81), in others the boundary is curved and the limit of the area is indistinct (Fig. 85).

In the type of *I. Lamarcki*, Parkinson (Fig. 63), the shell is inflated, and the posterior ear well developed and sharply limited. In forms like *I. Brongniarti* Sowerby (Fig. 70, Pl. LII, fig. 4), the posterior ear is also well developed, but

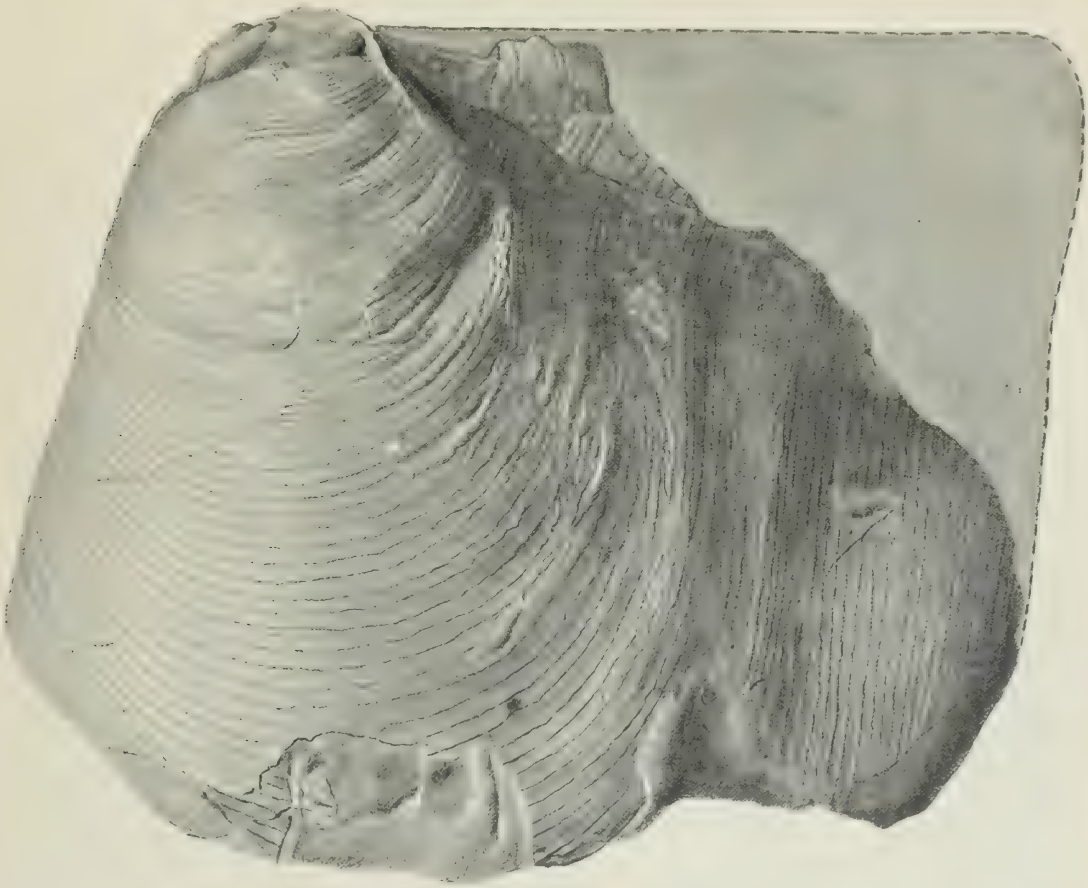


FIG. 75.—*Inoceramus Lamarcki* var. *Cuvieri*, Sow. Upper Chalk, Southeram, Lewes. Brighton Museum, No. 340. Portion of a left valve resembling the type of *I. latus*, Mant. × $\frac{7}{8}$.

not so sharply limited as in the type of *I. Lamarcki*. Mantell's *I. Lamarcki* (Fig. 66) is similar to *I. Brongniarti*, Sowerby, but has less prominent folds and a more concave anterior border. *I. Brongniarti*, Sowerby, passes gradually into forms like the type of *I. Brongniarti*, Mantell (Fig. 68), in which the limit of the posterior ear is somewhat indistinct. Other varieties possess similar strong folds but have less convex[1] valves (as in *I. Cuvieri*, Mantell, Figs. 69, 84), and these

[1] In some cases the smaller convexity may be due to pressure which gradually changed the shape of the shell. When no fractures are seen, flattening appears to be indicated in some cases by the growth-lines cutting the folds obliquely.

pass into forms with indistinct folds like the type of *I. Cuvieri*, Sowerby (Fig. 73), and in some cases the folds disappear altogether.

FIG. 76.—*Inoceramus Lamarcki* var. *Cuvieri*, Sow. The type of *Inoceramus latus*, Mantell, 'Foss. S. Downs,' p. 216, pl. xxvii, fig. 10. Upper Chalk, near Brighton. British Museum, No. 5848. Left valve. Natural size.

I. Websteri, Mantell (Figs. 71, 72), has the posterior ear fairly well developed, but not distinctly limited, and resembles *I. Brongniarti* of Mantell; it is characterised by the thinness of the shell and the sharp ridge-like folds, but forms

intermediate between this type and those with rounded folds occur. It may be convenient to adopt for this variety the name *I. Lamarcki* var. *Websteri.* It appears to occur mainly in the zone of *Micraster cor-testudinarium.*

I. undulatus, Mantell (Pl. LIII, fig. 3), resembles small forms of *I. Brongniarti,* Sowerby, but the folds are much smaller, more numerous, and less conspicuous, and the shell is thicker than usual.

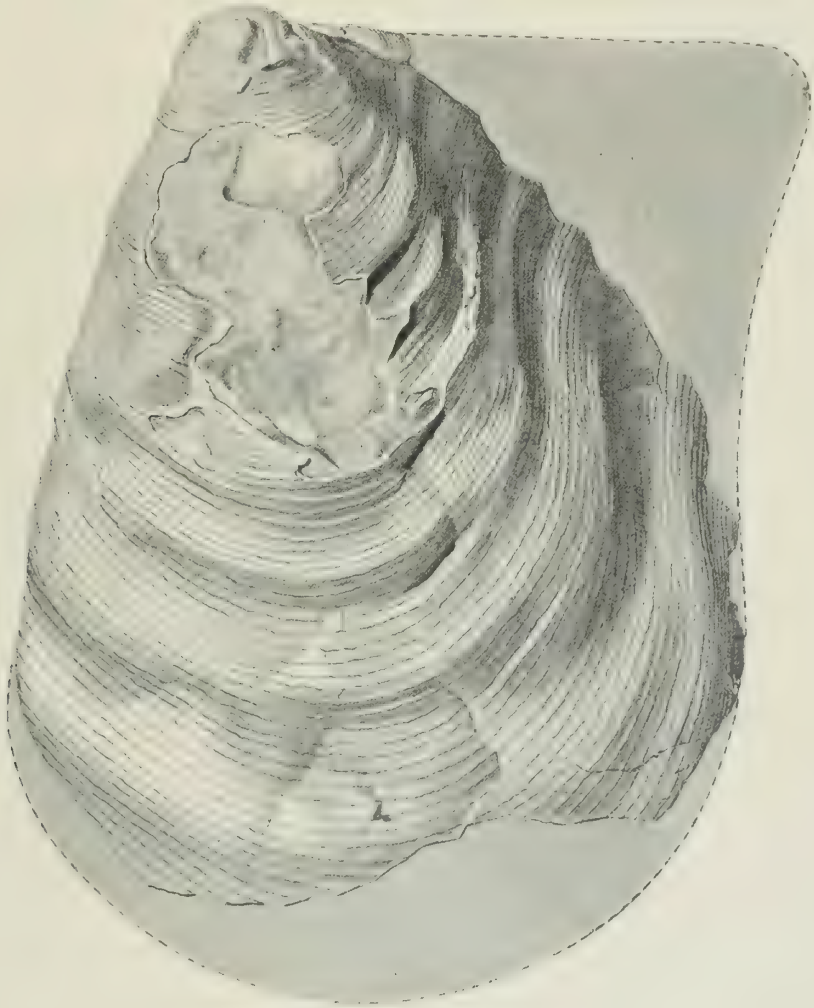


Fig. 77.—*Inoceramus Lamarcki* var. *Cuvieri,* Sow. Upper Chalk (zone of *Holaster planus*), Swaffham, Norfolk. Norwich Museum. Left valve. × $\frac{7}{8}$.

Some small forms (Pl. LIII, figs. 4—6), found in the Middle Chalk and in the zone of *Holaster planus,* which may be named *I. Lamarcki* var. *apicalis,*[1] have nearly equal valves, more prominent and more distinctly incurved umbones, with the folds indistinct or absent, but these forms pass into others with distinct folds. In some of these small forms the umbo is curved anteriorly (Plate LIII, fig. 4).

[1] An example of this from the Chalk Rock was figured in the 'Quart. Journ. Geol. Soc.,' vol. liii (1897), p. 381, pl. xxvii, fig. 13.

I. latus, Mantell (Fig. 76) is a large, slightly convex form in which the folds have almost disappeared. In the type (Fig. 76) the postero-dorsal part of the valve is missing, so that in Mantell's figure the umbonal part of the valve appears to be more acute than it really is (compare Fig. 75).

I. Cuvieri, Sowerby (Fig. 73) is only slightly convex, with indistinct folds, and is often of large size. The angle formed by the anterior margin and the hinge-line is rather larger than usual, and an anterior ear may be developed ; other forms

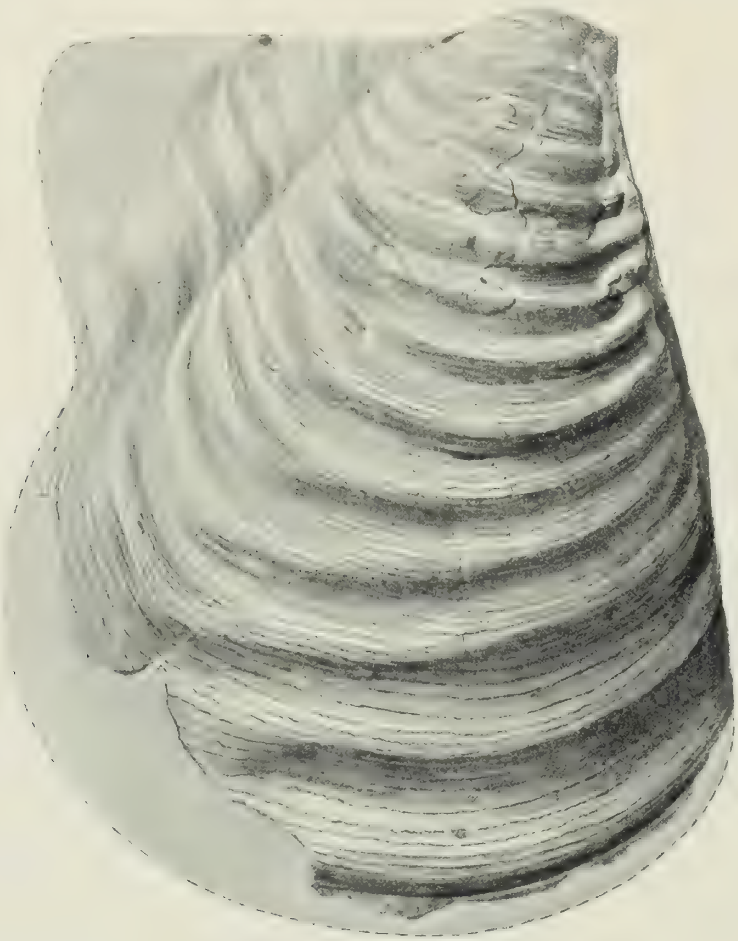


FIG. 78.—*Inoceramus Lamarcki* var. *Cuvieri,* Sow. Upper Chalk, Lewes. Sedgwick Museum, Cambridge. Right valve. Natural size.

are similar (Fig. 79), but have a smaller angle between the anterior margin and the hinge, and these pass into forms with more distinct and eventually with strong folds (Figs. 77, 78, 82). The varieties similar in form to Sowerby's type, but with or without folds, may be termed *I. Lamarcki* var. *Cuvieri* (Plate LIII, fig. 7, Text-figs. 73—84). The hinge in large specimens of this variety (Fig. 80) is of great thickness, and portions of it are often found separately. It is thickest near the umbo, and becomes thinner towards the posterior end. The ligament pits are numerous, shallow, and two, three, or more times higher than long,

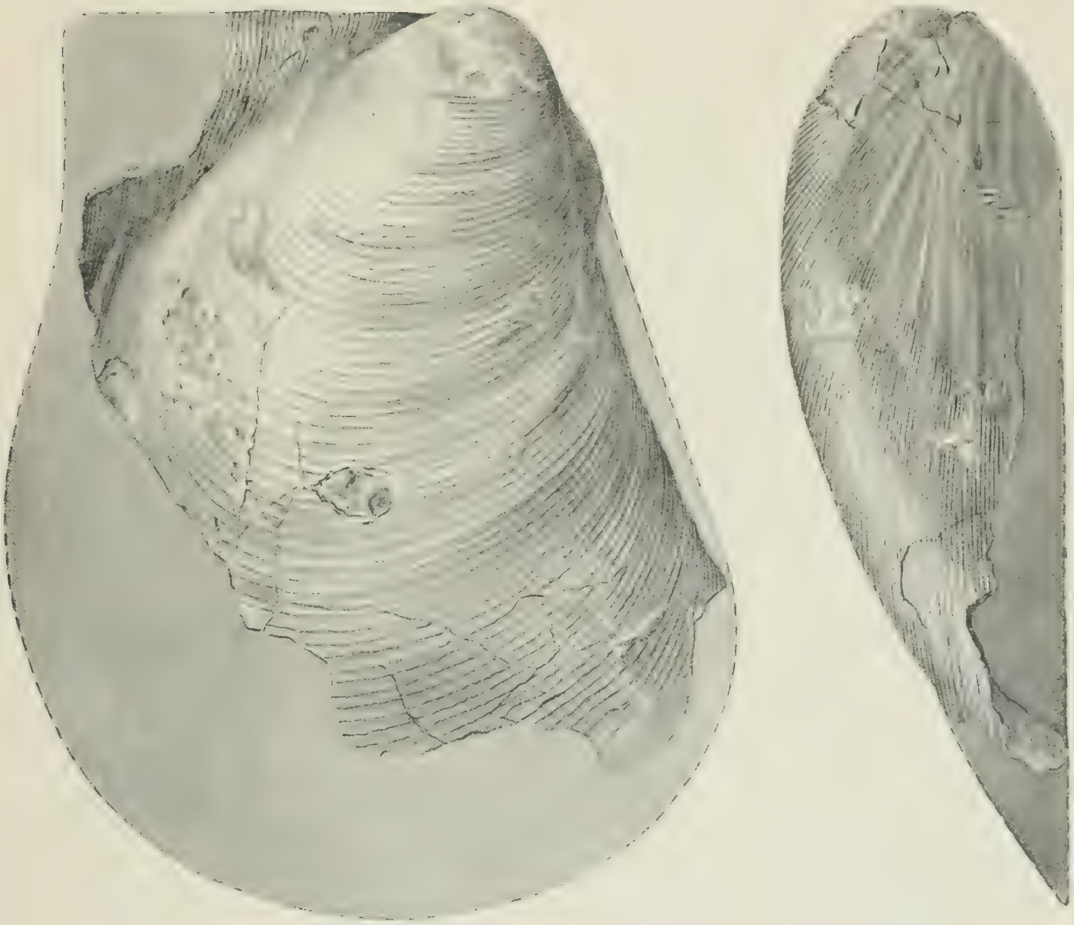


FIG. 79.—*Inoceramus Lamarcki* var. *Cuvieri*, Sow. Zone of *Holaster planus*, Borstal. Mr. Dibley's Collection. Right valve and anterior view. $\times \frac{7}{8}$.

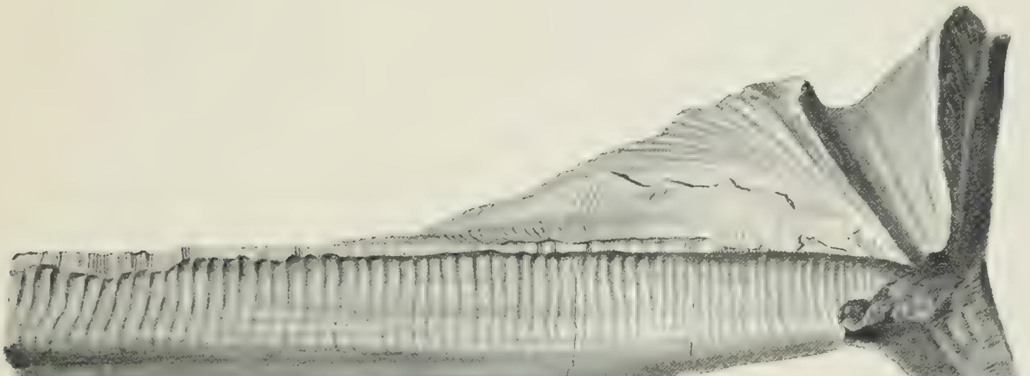


FIG. 80.—*Inoceramus Lamarcki* var. *Cuvieri*, Sow. Zone of *Terebratulina lata*, Royston. Sedgwick Museum, Cambridge. Portion of left hinge. Natural size.

reaching their maximum height not far from the umbo. The variety *Cuvieri* ranges from the zone of *Terebratulina lata* to the zone of *Micraster cor-anguinum.*

I. Mantelli, de Mercey,[1] from the zone of *Micraster cor-anguinum*, appears to be a large form of *I. Lamarcki* var. *Cuvieri*, in which an anterior ear is developed; it is similar to a specimen (Fig. 74) obtained by Dr. Blackmore from the zone of *Micraster cor-anguinum* of Camp Hill near Salisbury.

FIG 81.—*Inoceramus Lamarcki* var. *Cuvieri*, Sow. Zone of *Terebratulina lata*, Blue Bell Hill, Burham. Mr. Dibley's Collection. Left valve with posterior part missing; anterior view of the same valve. × $\frac{7}{8}$.

I. percostatus, Müller[2] (especially the example figured by Petrascheck[3]), seems to be closely allied to *I. Lamarcki* var. *Websteri*.

Types.—*I. Lamarcki*, Parkinson (Fig. 63), from near Dover (probably zone of

[1] 'Mém. Soc. Linn. Nord de la France,' vol. iv (1877), p. 324. pls. i, ii. Barrois, 'Ann. Soc. géol. Nord,' vol. vi (1879), p. 454, pl. iv.

[2] 'Jahrb. d. k. preuss. geol. Landesanst. u. Bergakad. für 1887' (1888), p. 413, pl. xvii, fig. 3.

[3] 'Jahrb. d. k. k. geol. Reichsanst.,' vol. lvi (1906), p. 163, fig. 2. Also *I. Glatziæ* and *I. Kleini*, Andert, 'Inoceramen d. Kreibitz-Zittauer Sandsteingeb.' (1911), pp. 48, 52, pl. i, fig. 3, pl. ii, fig. 8.

Micraster cor-anguinum) ; in the British Museum, No. L9801. This specimen was first recognised as the original of Parkinson's figure by Mr. C. D. Sherborn.

Fig. 82.—*Inoceramus Lamarcki* var. *Cuvieri*, Sow. Chalk; locality and horizon unknown. British Museum, No. L23909. Right valve. × ½.

I. Cuvieri, Sowerby (Fig. 73), from the Middle Chalk of Royston (zone of *Terebratulina lata*) ; in the British Museum, No. 43264.

I. Lamarcki, Mantell (Fig. 66), from the Middle Chalk near Lewes (probably from Malling, zone of *Terebratulina lata*) ; in the British Museum, No. 4753.

I. Cuvieri, Mantell (Figs. 69, 84), both from the zone of *Micraster cor-anguinum* of Southeram; in the British Museum, Nos. 5845, L22094.

I. Brongniarti, Mantell (Fig. 68), from Lewes or Brighton (probably zone of *Micraster cor-anguinum*); in the British Museum, No. 4751.

Fig. 83.—Anterior view of specimen shown in Fig. 82. × ½.

I. Websteri, Mantell (Fig. 71), from South Street [= Southeram], Lewes (probably zone of *Micraster cor-testudinarium*); in the British Museum, No. 4759.

I. undulatus, Mantell (Plate LIII, fig. 3), from Southeram, Lewes (probably zone of *Holaster planus*); in the British Museum, No. 4767.

FIG. 84.—*Inoceramus Lamarcki* var. *Cuvieri*, Sow. The original of *I. Cuvieri*, Mantell, 'Foss. S. Downs,' p. 213, pl. xxviii, fig. 1. Zone of *Micraster cor-anguinum* of Southeram. British Museum, No. 5845. × ½.

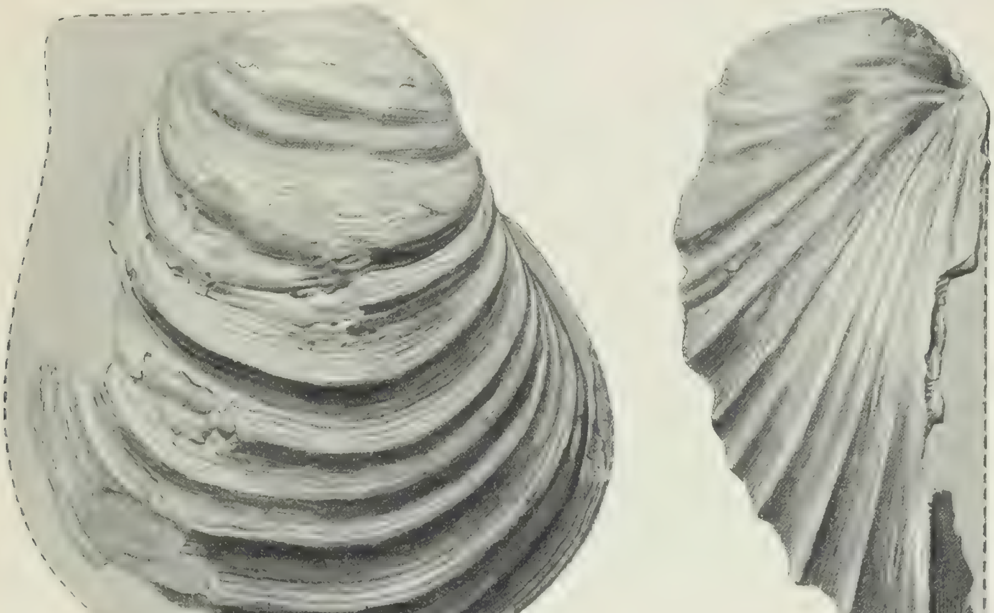


FIG. 85.—*Inoceramus Lamarcki*, Park. Upper Chalk (? zone of *Holaster planus*), locality unknown. Museum of Practical Geology, No. 21237. Variety with concave anterior area. Right valve and anterior view. × ⅞.

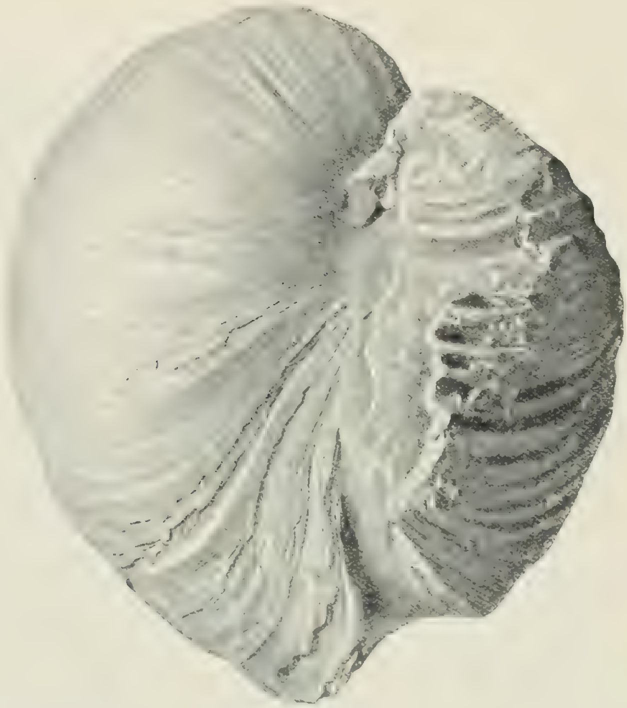


Fig. 86.—*Inoceramus*. A variety connecting *I. Lamarcki* with *I. involutus*. Upper Chalk, probably Kent. Sedgwick Museum Right valve displaced. Posterior view. × $\frac{7}{8}$.

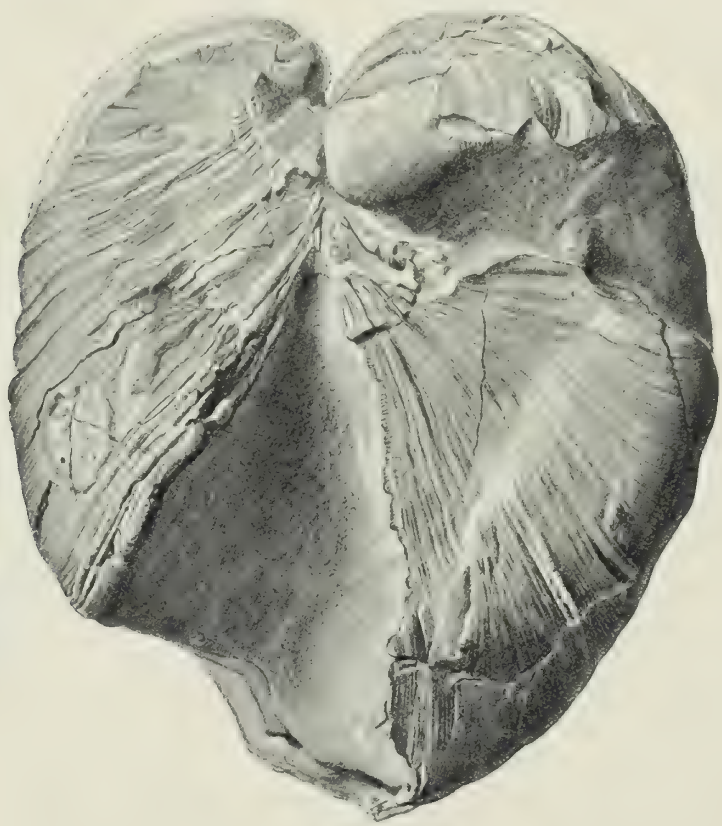


Fig. 87.—Anterior view of specimen shown in Fig. 86. Natural size.

I. latus, Mantell (Fig. 76), from the Upper Chalk near Brighton; in the British Museum, No. 5848.

I. Brongniarti, Sowerby, 1823 (Fig. 70). Locality and horizon unknown; in the British Museum, No. 43265.

The small specimens from the zone of *Rhynchonella Cuvieri* near Cambridge, figured by Etheridge as *Inoceramus problematicus*, are in the Museum of Practical Geology (Nos. 21230—21232).

Distribution.—*I. Lamarcki* ranges from the zone of *Rhynchonella Cuvieri* to the zone of *Micraster cor-anguinum*.[1]

Zone of *Rhynchonella Cuvieri*: St. Catherine's Hill (Winchester), the Isle of Wight, Cuxton, Burham, Dunton Green, the Sussex coast, Dover, Hitchin, Foulbourn near Cambridge, the Yorkshire coast.

Zone of *Terebratulina lata*: Hooken (South Devon), the Isle of Wight, Cuxton, Blue Bell Hill (Burham), Dunton Green, Kenley, Westerham, Lewes, the Sussex coast, Holborough near Rochester, Dover, Guilford Colliery (Coldred near Dover), Hitchin, Royston, the Yorkshire coast.

Zone of *Holaster planus*: The South Devon and Dorset coasts, the Isle of Wight, Winchester, Homington (Salisbury), Cuxton, Borstal, Whyteleaf (Warlingham), the Sussex coast, Dover, Newmarket, Swaffham (Norfolk), Westacre, Narborough, the Yorkshire coast. Chalk Rock of Cuckhamsley.

Zone of *Micraster cor-testudinarium*: The South Devon and Dorset coasts, the Isle of Wight, Borstal Fort, Borstal Manor pit, Chatham, Lewes, the Sussex coast, Dover, Wharram Percy, the Yorkshire coast.

Zone of *Micraster cor-anguinum*: The Dorset coast, the Isle of Wight, Camp Hill (Salisbury), Micheldever, Harefield, Southeram, the Sussex coast, St. Margaret's, Thanet, the Yorkshire coast.

Senonian of Haldon.

INOCERAMUS INVOLUTUS, *Sowerby*, 1828. Text-figs. 88—94.

1828.	INOCERAMUS	INVOLUTUS, *J. de C. Sowerby.*		Min. Conch., vol. vi, p. 160, pl. dlxxxiii, figs. 1—3.
1841.	—	—	*F. A. Römer.*	Die Verstein. d. nord-deutsch. Kreidegeb., p. 61.
1846.	—	—	*A. d'Orbigny.*	Pal. Franç. Terr. Crét., vol. iii, p. 520, pl. ccccxiii, figs. 1—3.
—	—	LAMARCKII, *d'Orbigny.*		Ibid., p. 518, pl. ccccxii.
1850.	—	INVOLUTUS, *d'Orbigny.*		Prodr. de Pal., vol. ii, p. 250.

[1] Some authors have recorded this species from the zones of *Marsupites testudinarius, Actinocamax quadratus* and *Belemnitella mucronata*, but I have not sufficient evidence to confirm these records.

1850. Inoceramus involutus, *J. de C. Sowerby*, in *F. Dixon.* Geol. Sussex, p. 355 (p. 386, ed. 2), pl. xxviii, fig. 32.

1854. — — *J. Morris.* Cat. Brit. Foss., ed. 2, p. 169.

1863. — — *A. v. Strombeck.* Zeitschr. d. deutsch. geol. Gesellsch., vol. xv, p. 127.

1871. — (Volviceramus) involutus, *F. Stoliczka.* Palæont. Indica, Cret. Fauna S. India, vol. iii, pp. 394, 401.

1875. — involutus, *C. Décocq.* Assoc. Franç. Avanc. Sci. (Lille, 1874), p. 367.

1876. — — *D. Brauns.* Zeitschr. f. d. gesammt. Naturwiss., vol. xlvi, p. 379.

1877. — — *C. Schlüter.* Palæontographica, vol. xxiv, p. 272.

1878. — — *C. Barrois.* Ann. Soc. géol. du Nord, vol. v, p. 475.

1888. — (Volviceramus) involutus, *G. Müller.* Jahrb. d. k. preuss. geol. Landesanst. für 1887, p. 411, pl. xvi, figs. 3, 4.

— — involutus, *A. Peron.* Hist. Terr. Craie S.E. du Bassin Anglo-Parisien, p. 157.

1901. — — *F. Sturm.* Jahrb. d. k. preuss. geol. Landesanst. für 1900, vol. xxi, p. 91, pl. ix, fig. 4.

1902. — — *A. Wollemann.* Lüneburg. Kreide (Abhandl. d. k. preuss. geol. Landesanst. n.f., 37), p. 68, pl. i, fig. 4; pl. ii, figs. 7, 8.

1906. — — *G. Smoleński.* Bull. Intern. Acad. Sci. Cracovie, p. 721.

1909. — — *J. Nowak.* Ibid., p. 874, pl. xlvi, figs. 4, 5.

1910. — — *J. Böhm.* Centralbl. für Min., etc., p. 741.

Description.—Shell very inequivalve and very inequilateral. Right valve oval or semi-oval in outline; usually slightly convex, but sometimes either more convex or nearly flat, with the marginal part in old specimens forming an obtuse angle with the earlier part. Length greater than height. Anterior and ventral margins rounded; posterior margin forming usually an obtuse angle but sometimes nearly a right angle with the hinge. Umbo usually inconspicuous, at or near the anterior end of the hinge-line. Hinge-line equals about three-quarters of the length of the valve. Postero-dorsal marginal part convex near the hinge and separated by a sharp furrow from the remainder of the valve. Ornamentation consists of strong, somewhat irregular concentric folds, with an unsymmetrical curvature; the folds are separated by broad, concave interspaces. In casts of this valve, and sometimes in the shell itself, radial markings are seen in the concave interspaces.

Left valve much larger than the right, inflated, more or less considerably

FIG. 88.—*Inoceramus involutus*, Sow. Upper Chalk, locality unknown. The type. British Museum, No. 43268. Left valve. Natural size.

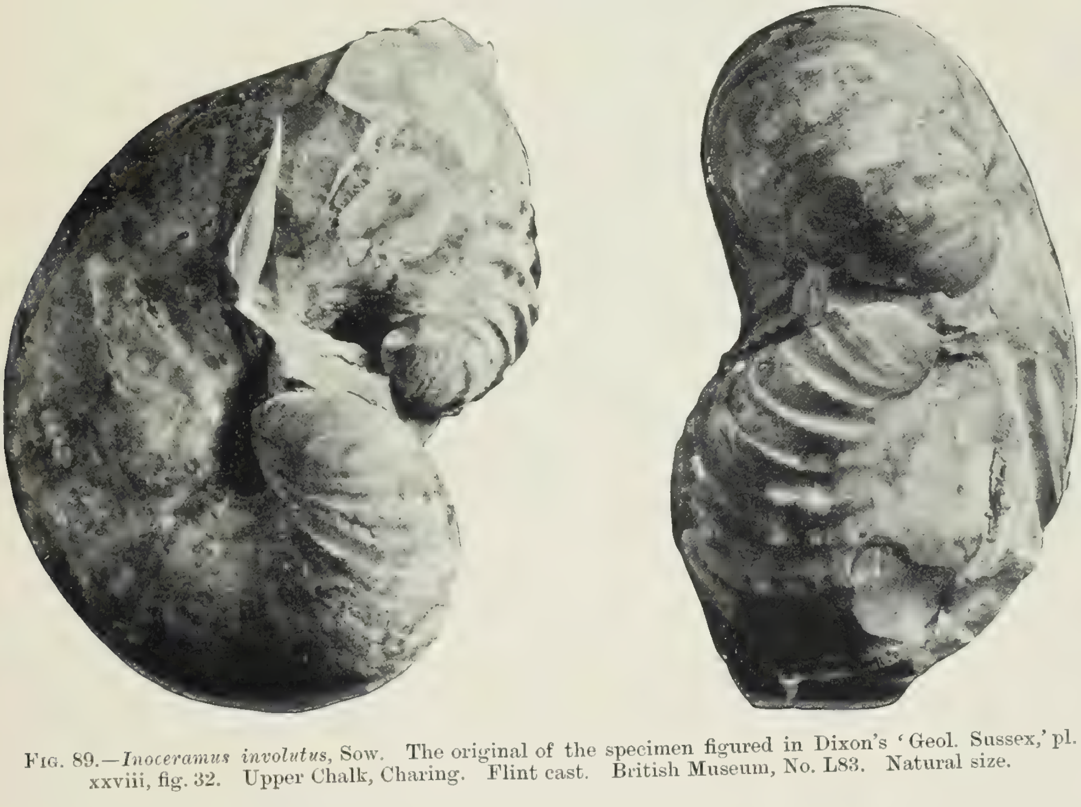


FIG. 89.—*Inoceramus involutus*, Sow. The original of the specimen figured in Dixon's 'Geol. Sussex,' pl. xxviii, fig. 32. Upper Chalk, Charing. Flint cast. British Museum, No. L83. Natural size.

Fig. 90.—*Inoceramus involutus*, Sow. Upper Chalk, probably Kent. British Museum, No. L4917. Posterior view. Umbonal part of left valve missing. Natural size.

Fig. 91.—Anterior view of specimen shown in Fig. 90. Natural size.

spiral; with a very large umbo near the anterior end, curved inwards and forwards. Surface nearly smooth, except for the presence of growth-lines.

The hinge (Fig. 94) curves at either end; it is thinnest near the umbo and becomes thicker towards the posterior end. The ligament-pits are deep, almost square, but sometimes oblong, and increase in height from the umbo posteriorly.

FIG. 92.—Right valve and part of left valve of specimen shown in Figs. 90, 91.

Affinities.—*I. involutus* is the type of the genus or sub-genus *Volviceramus* of Stoliczka. In general appearance this differs considerably from other species of *Inoceramus*, so that its separation as a distinct genus or sub-genus seems at first sight quite justifiable; but the study of a large number of specimens of *I. involutus* and *I. Lamarcki* shows that these two species are very closely allied, and that the former has almost certainly descended from the latter. Such being the case it follows that these two species are more nearly related to one another than are

several species which are placed by all writers in the genus *Inoceramus*. In this respect *Volviceramus* is exactly comparable with *Actinoceramus* (p. 268).

A fairly complete passage can be traced from *I. Lamarcki* to *I. involutus*. In some forms of *I. Lamarcki* the valves become more unequal than usual, the left

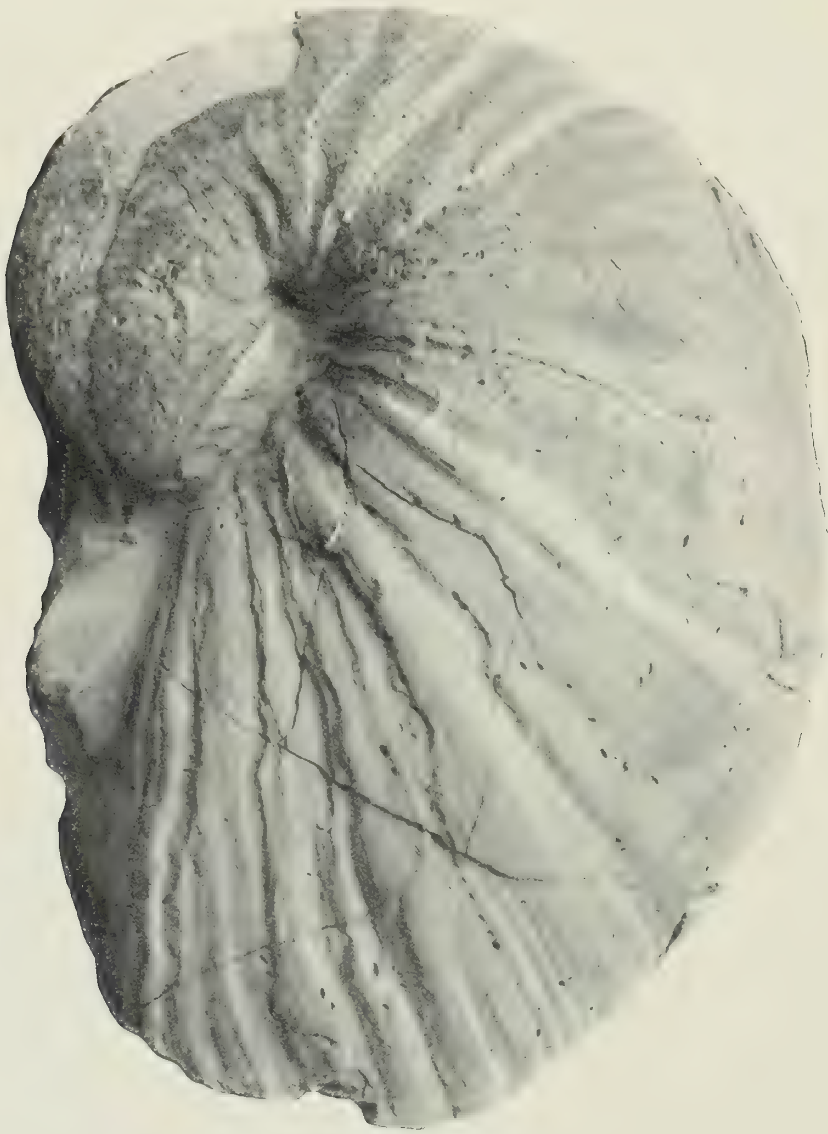


Fig. 93.—*Inoceramus involutus*, Sow. Upper Chalk, locality unknown. British Museum, No. L21005. Anterior view of left valve. × $\frac{7}{8}$.

valve being relatively larger and with less distinct folds, and the right relatively less convex and its anterior area slightly concave (Fig. 85). These are connected with some varieties of *I. involutus* by intermediate forms (Figs. 86, 87) in which the left valve possesses nearly all the characters of *I. involutus* but is less curved and possesses a concave anterior area, whilst on the right valve the folds are almost as prominent as in *I. involutus*, but the flattened or concave anterior area

and a relatively short hinge are still retained, and the right valve is still convex and has a concave anterior area. A variety of *I. involutus* links such intermediate forms with typical examples of *involutus*; in that variety the right valve is rather more convex than in typical forms, the left valve is not so distinctly spiral, some trace of the anterior flattened or concave area is still retained, and the hinge-line is rather shorter relatively.

FIG. 94.—*Inoceramus involutus*, Sow. Upper figure: Zone of *Micraster cor-anguinum*, Gravesend. Sedgwick Museum, Cambridge. Right valve with marginal growth round the hinge. $\times \frac{7}{8}$.
Lower figure: Hinge of right valve; Upper Chalk, Norfolk. Norwich Museum, No. 3355. The anterior part of the hinge is partly concealed by the marginal growth of the shell. $\times \frac{7}{8}$.

I. umbonatus, Meek and Hayden,[1] from Fort Benton, Missouri, is, as stated by Meek, very closely allied to, and perhaps identical with, *I. involutus*. Another related form is *I. exogyroides*, Meek and Hayden.[2] Both are regarded as synonyms

[1] 'Invert. Cret. and Tert. Foss. U. Missouri' (1876), p. 44, pl. iii, fig. 1; pl. iv, figs. 1, 2.
[2] Ibid., p. 46, pl. v, fig. 3.

of *I. involutus* by Barrois. *I. Koeneni*, Müller,[1] is probably a variety of *I. involutus* in which the right valve is more convex and its umbo more prominent than usual.

The right valve of the specimen figured by d'Orbigny (1846, pl. ccccxii, figs. 1, 2) as *I. Lamarcki* is an example of *I. involutus*; but the left valve (fig. 3), if it belongs to the same individual, is probably incorrectly drawn.

Remarks.—Examples of this species often reach a large size, and in such cases the hinge (Fig. 94) may attain a considerable thickness, but portions of it are not often found separately. In old specimens the marginal part of the right valve grows obliquely or almost at right angles to the earlier part, and the folds become indistinct or disappear altogether; and in the right valve this marginal growth sometimes occurs along the hinge, owing no doubt to the increase in size of the left valve in which it then fits like an operculum (Fig. 94). The length varies in proportion to the height, so that in some forms the right valve becomes nearly circular.

Types.—The type (Fig. 88) is in the British Museum, No. 43268; its locality is unknown. The specimen figured in Dixon's 'Geology of Sussex' (Fig. 89) is also in the British Museum, No. L83; it is a flint cast and came from the Upper Chalk of Charing.

Distribution.—*I. involutus* is found in the zone of *Micraster cor-testudinarium* and the lower part of the zone of *M. cor-anguinum*, being particularly common at the latter horizon.[2]

Zone of *M. cor-testudinarium:* Chatham, Dover, and Seaford, Sussex.

Zone of *M. cor-anguinum:* Winchester, Quidhampton, Mapledurham, Thanet, St. Margaret's, Guilford Colliery (Coldred near Dover), the Sussex coast, Lewes, Haling pit (South Croydon), Strood, New Brompton (Chatham), Gravesend, Harefield near Rickmansworth, Bury St. Edmunds, Saham Toney, Thetford, Brancaster, and other places in Norfolk. Between the zones of *M. cor-testudinarium* and *M. cor-anguinum* near Beverley, Yorkshire. Senonian of Haldon.

INOCERAMUS CORDIFORMIS, *Sowerby*, 1823. Plate LIII, fig. 8. Plate LIV, figs. 2—4.

1823. INOCERAMUS CORDIFORMIS, *J. de C. Sowerby.* Min. Conch., vol. v, p. 61. pl. ccccxl.
1836. — — *A. Goldfuss.* Petref. Germ., vol. ii, p. 113, pl. cx, fig. 6*b* (not 6*a*).

[1] 'Jahrb. d. k. preuss. geol. Landesanst.' für 1887 (1888), p. 412, pl. xvii, fig. 1.

[2] This species has been recorded by Griffith and Brydone from the *Uintacrinus* band of the *Marsupites* zone of Ropley, Hampshire; and by Barrois from the zone of *Actinocamax quadratus* of Newhaven.

1854.	INOCERAMUS CORDIFORMIS, *J. Morris.*		Cat. Brit. Foss., ed. 2, p. 169.
1897.	—	— *R. Leonhard.*	Palæontographica, vol. xliv, p. 48.
1898.	—	HAENLEINI, *G. Müller.*	Mollusk. Untersen. v. Braunschweig u. Ilsede (Abhandl. d. k. preuss. geol. Landesanst., N.F., 25), p. 41, pl. v, fig. 7; pl. vi, figs. 1, 2.
? 1911.	—	CORDIFORMIS, *W. Rogala.*	Bull. Internat. Acad. Sci. Cracovie, p. 170, pl. iv, fig. 2.
Non 1904.	—	— *C. Airaghi.*	Boll. Soc. geol. Italiana, vol. xxiii, p. 189, pl. iv, figs. 6—9.

Description.—Shell inflated, equivalve, very inequilateral, rounded. Anterior margin more or less nearly straight or undulating, but rounded in large specimens. Ventral and posterior margins more or less sinuous. Anterior part of valves more or less flattened and often nearly perpendicular to the plane between the valves. Postero-dorsal part of valves much compressed and usually wing-like. Hinge equal to more than half the height of the shell. Umbones terminal, large, prominent, curved inwards and forwards. A broad, shallow sulcus extends from behind the umbo to the postero-ventral extremity and separates two broad, rounded ridges. A similar sulcus may extend from the front of the umbo to the opposite ventral margin.

Ornamentation consists of broad, rounded, concentric folds, which bend upwards where they cross the two radial sulci. The folds become less distinct on the anterior and postero-dorsal parts than on the sides of the shell. Numerous close-set growth-lines are present.

Affinities.—*I. Haenleini*, Müller,[1] from the lower part of the Lower Senonian of Brunswick and Ilsede, seems to be hardly distinct from *I. cordiformis*. The smaller English specimens agree very closely with one of the examples figured by Müller (pl. v, fig. 7).

I. cordiformis resembles some of the more convex forms of *I. Lamarcki*, Parkinson, from which it is distinguished by the equal size of the valves and the presence of radial sulci. The specimen, figured (Pl. LIV, fig. 1), connects this species with *I. Lamarcki*.

Remarks.—Goldfuss' fig. 6*b* is a copy of Sowerby's figure; his fig. 6*a* is the type of *I. saxonicus*, Petrascheck.

Type.—In the British Museum, No. 43277, from the Upper Chalk (zone of *Micraster cor-anguinum*) of Gravesend (Pl. LIII, fig. 8).

Distribution.—Zone of *Micraster cor-testudinarium* of Clanfield (Hampshire), and Wharram Percy (Yorkshire). Zone of *Micraster cor-anguinum* of Gravesend, Micheldever, and Porton. *Uintacrinus* band of Salisbury. Senonian of Haldon.

[1] 'Mollusk. Untersen. v. Braunschweig u. Ilsede' (1898), p. 41, pl. v, fig. 7; pl. vi, figs. 1, 2.

INOCERAMUS COSTELLATUS, sp. nov. Plate LIV, figs. 5—7.

1897. INOCERAMUS, sp., *H. Woods.* Quart. Journ. Geol. Soc., vol. liii, p. 381, pl. xxvii, figs. 14—17.

Description.—Shell small, very inequilateral, rather higher than long, of moderate convexity—the greatest convexity being between the umbones and the postero-ventral extremity. Umbones terminal. Hinge equal to about three-quarters of the length of the shell, and forming more than a right angle with the anterior margin. Anterior margin moderately convex, ventral margin very convex, posterior margin slightly convex.

Right valve with a small, pointed, slightly curved umbo. Posterior and postero-dorsal parts of the valve flattened. A small, flattened antero-dorsal area is nearly perpendicular to the plane of the valves.

Left valve more convex than the right; postero-dorsal part compressed, but not forming a definite ear. Umbo narrow, pointed, curved inwards, larger and more prominent than the umbo of the right valve. Antero-dorsal area larger than on the right valve.

Concentric ribs narrow, sharp, usually widely separated; interspaces broad and shallow. The curvature of the ribs is very unsymmetrical; the ventral part is very convex, the posterior part only slightly convex.

Remarks.—This species is fairly common in the Chalk Rock. All the specimens seen are casts. Some examples, which appear to be a variety of this species, have small ribs of uniform size.

Affinities.—This species appears to be related to some forms of *I. Lamarcki*, Parkinson, but the left umbo is narrower, more pointed, and less curved; the line of greatest convexity is more oblique to the hinge-line, and the posterior and postero-dorsal parts of the valves are more compressed.[1]

Type.—From the Chalk Rock of Cuckhamsley, in the Sedgwick Museum, Cambridge.

Distribution.—Chalk Rock of Dover, Guilford Colliery (Coldred near Dover), the Sussex Coast, south-east of Calstone Willington, Cuckhamsley, Blount's Farm near Marlow, Luton, Wallington near Baldock, Barley near Royston, and Underwood Hall near Dullingham. Zone of *Holaster planus* of South Devon, the Dorset Coast, the Isle of Wight, Lichfield (Hants), Winchester, etc.[2]

[1] Compare also *I. undulatus*, Rogala, 'Bull. Internat. Acad. Sci. Cracovie' (1911), p. 171, pl. iv, fig. 7, and *I. Frechi*, Andert, 'Inoceramen d. Kreibitz-Zittauer Sandsteingeb.' (1911), p. 51, pl. i, fig. 8.

[2] Recorded by Rowe from the zones of *Terebratulina lata* and *Micraster cor-anguinum* of Dover.

INOCERAMUS DIGITATUS, *Sowerby*, 1829. Text-fig. 95.

1829. INOCERAMUS DIGITATUS, *J. de C. Sowerby*. Min. Conch., vol. vi, p. 215, pl. dciv, fig. 2.
1854. — — *J. Morris*. Cat. Brit. Foss., ed. 2, p. 169.
? 1875. — — *C. Décocq*. Assoc. Franç. Avanc. Sci. (Lille, 1874), p. 368.

Remarks.—This species attains a large size, but is known only by small

FIG. 95.—*Inoceramus digitatus*, Sow. The type. From the Drift (derived from the Chalk). British Museum, No. 43273. × $\frac{3}{4}$.

portions of the shell of which the exact horizon cannot be determined. The ornamentation consists of broad, rounded, radial folds, which diverge very gradually and are separated by broad rounded interspaces. Small concentric ribs occur, and at distant intervals, broad, gentle, concentric folds can be traced. The form referred to *I. digitatus* by Schlüter differs from that species in having

diverging and distinctly curved ribs. *I. digitatus* appears to be closely allied to *I. subcardissoides*, Schlüter.

Type.—From the Drift (derived from the Chalk); locality unknown. In the British Museum, No. 43,273.

Distribution.—No undoubted specimens obtained directly from the Chalk have been seen.

INOCERAMUS PINNIFORMIS, *Willett*, 1871. Text-fig. 96.

1871. INOCERAMUS PINNIFORMIS, *H. Willett.* Cat. Cret. Foss., Brighton Mus., p. 40, no. 342.

Description.—Shell very large, much higher than long, of moderate convexity, with a posterior wing-like part.

Ornamentation consists of broad, strong, widely separated concentric folds which have a nearly symmetrical curvature; the ventral slopes of the folds are rather steeper than the dorsal; in the interspaces are small (sometimes indistinct) concentric folds, which give a more or less marked tuberculate character to the radial ribs. The latter are rounded, rather numerous, sometimes partly or completely divided by a median furrow, and are continued on to the dorsal surfaces of the strong concentric folds, but are absent or indistinct on the ventral surfaces.

Remarks.—A portion of a large *Inoceramus* named *I. pinniformis* by Willett resembles *I. subcardissoides*, Schlüter,[1] but differs from that species by the more numerous radial ribs and the absence of a broad furrow extending from the umbo in a postero-ventral direction.

Type.—In the Brighton Museum.

Distribution.—Upper Chalk (zone of *Actinocamax quadratus*) of Brighton, and three miles east of Sledmere, Yorkshire.

[1] 'Palæontographica,' vol. xxiv (1877), p. 271, pl. xxxvii; Barrois, 'Ann. Soc. géol. Nord.,' vol. v (1878), p. 474; Wollemann, 'Lüneburg. Kreide' (1902), p. 70; Wegner, 'Zeitschr. d. deutsch. geol. Gesellsch.,' vol. lvii (1905), p. 169; *I. Gosseleti*, Décocq, 'Assoc. Franç. Avanc. Sci.,' 1874 (1875), p. 371.

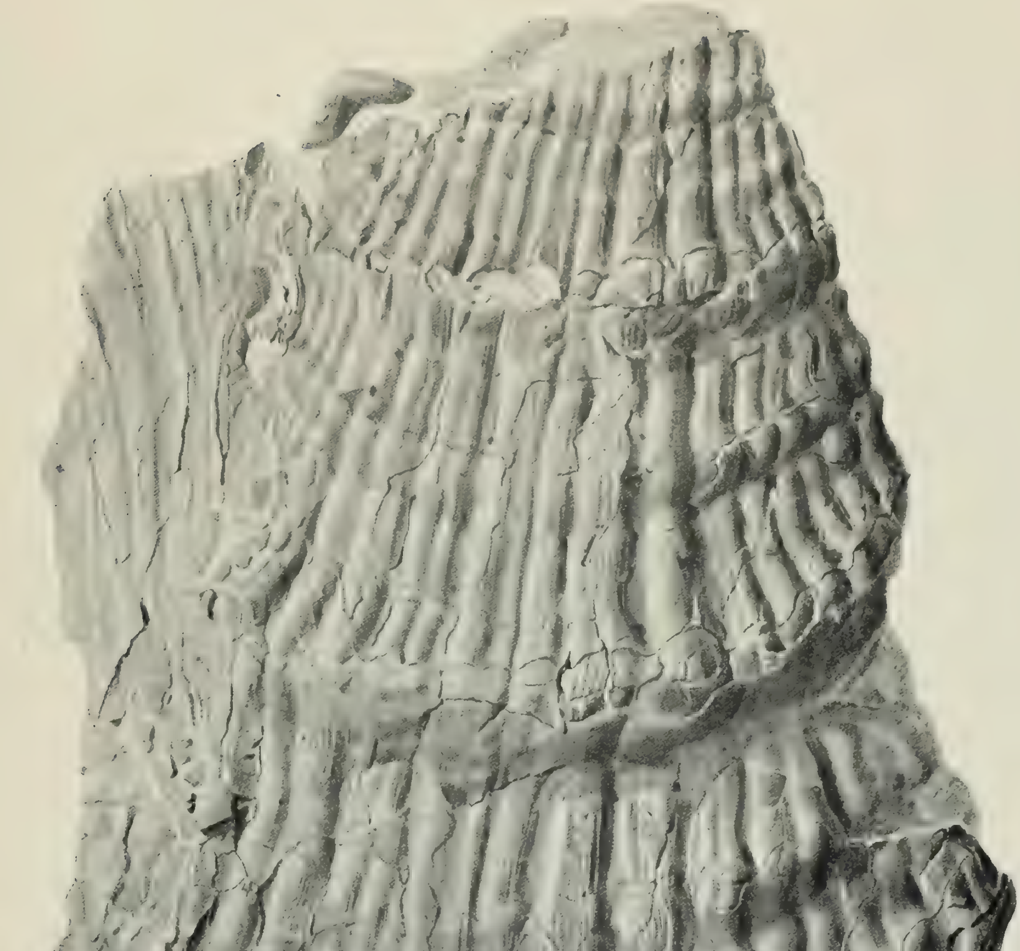


Fig. 96.—*Inoceramus pinniformis*, Willett. Upper Chalk (zone of *Actinocamax quadratus*), Brighton. Brighton Museum, No. 342. Portion of right valve. × $\frac{2}{3}$.

INOCERAMUS CORRUGATUS, sp. nov. Text-fig. 97.

Remarks.—This species is at present known only by a small portion of one valve. It is of the same general type as *I. digitatus*, Sowerby, *I. pinniformis*, Willett, and *I. subcardissoides*, Schlüter, but owing to the presence of broad, strong radial folds the radial ribs are arranged in groups of four or five. The

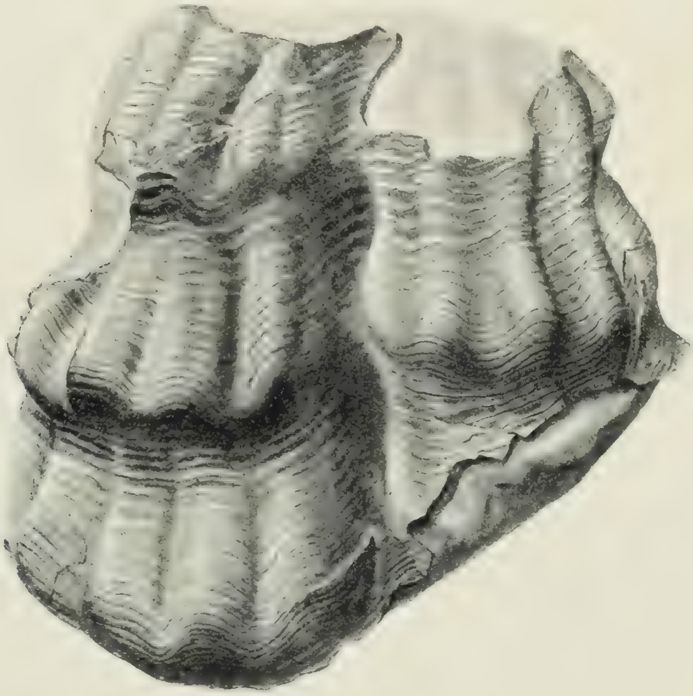


FIG. 97.—*Inoceramus corrugatus*, sp. nov. Upper Chalk, Wouldham Cement Quarry, Grays. British Museum, No. L22528 (discovered and presented by Col. C. E. Shepherd). Natural size.

concentric folds are strong and have a steep ventral, and a gentle dorsal slope. The growth-lines are distinct and regular. *I. corrugatus* and the other species mentioned may be compared with *I. lezennensis*, Décocq,[1] which is of the same type as *I. Lamarcki* but possesses two radial folds due to the presence of a medial sulcus.

Distribution.—Upper Chalk, Wouldham Cement Company's Quarry, Grays, Essex.

[1] Barrois, 'Ann. Soc. géol. du Nord,' vol. vi (1879), p. 455, pl. 5, figs. 1, 2.

PLATE LI.

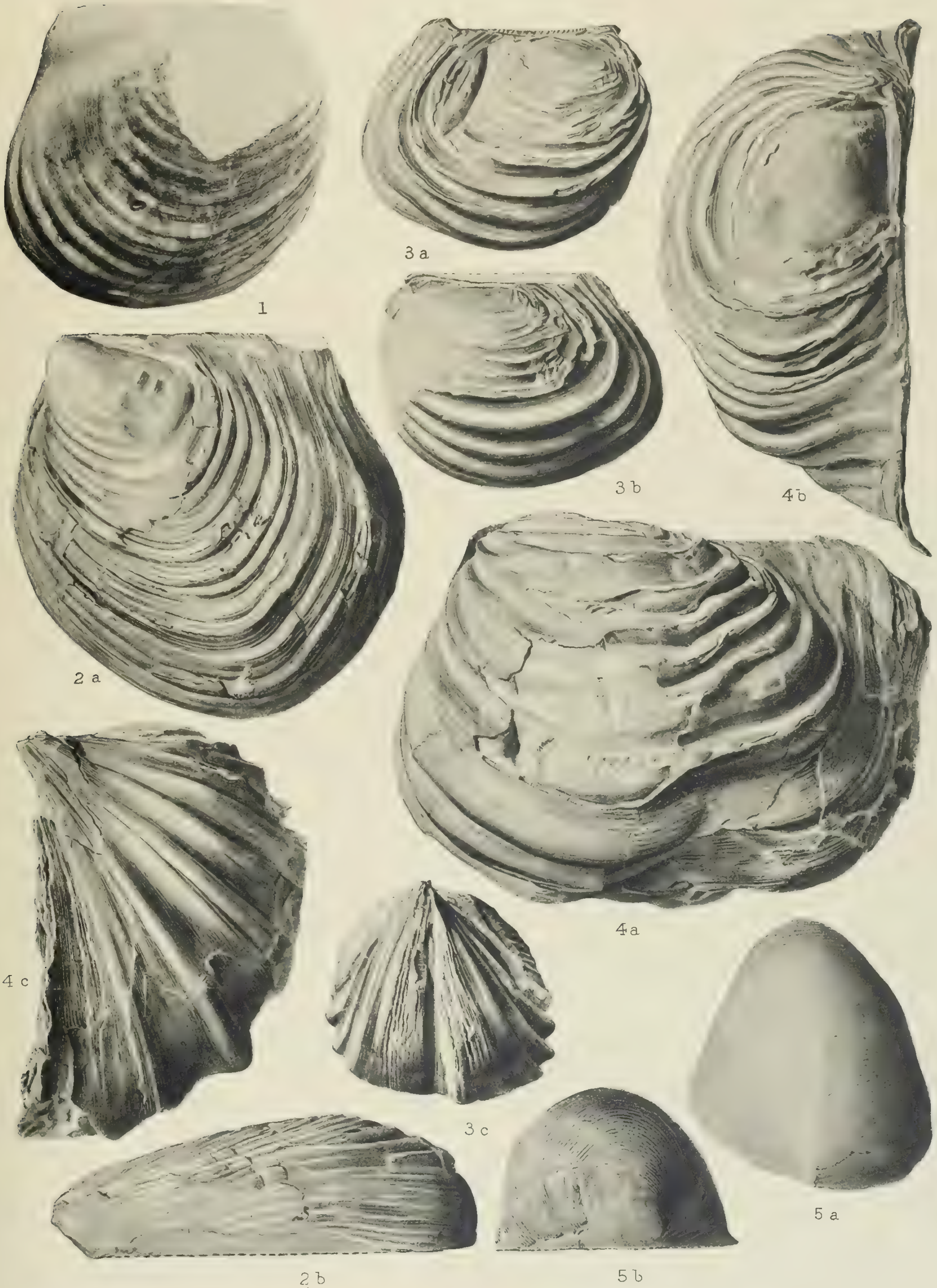
INOCERAMUS (*continued.*)

FIGS.

1—4. *I. inconstans*, Woods. Upper Chalk. (P. 285.)

1. Sussex (probably from the zone of *Terebratulina lata* of Malling). British Museum, No. L20955. The original of *I. Lamarcki*, Sowerby, in Dixon, 'Geol. Sussex,' pl. xxviii, fig. 29. Right valve.
2. Zone of *Holaster planus*, Swaffham, Norfolk. Norwich Museum. *a*, left valve; *b*, anterior view of the same.
3. Zone of *Actinocamax quadratus*, East Harnham, Salisbury. Dr. Blackmore's Collection. *a*, right valve; *b*, left valve; *c*, posterior view of both valves.
4. Same zone, etc. *a*, left valve; *b*, dorsal view; *c*, anterior view.

5\. *I. inconstans* var. *striatus*, Mant. Zone of *Micraster cor-anguinum*, Southeram. British Museum, No. 4768. The Type of *I. striatus*, Mant. *a*, left valve; *b*, dorsal view of the same. (P. 292.)



CRETACEOUS LAMELLIBRANCHIA.

T.A. Brock, del.

London Stereoscopic Co. Imp

PLATE LII.

Inoceramus (*continued*).

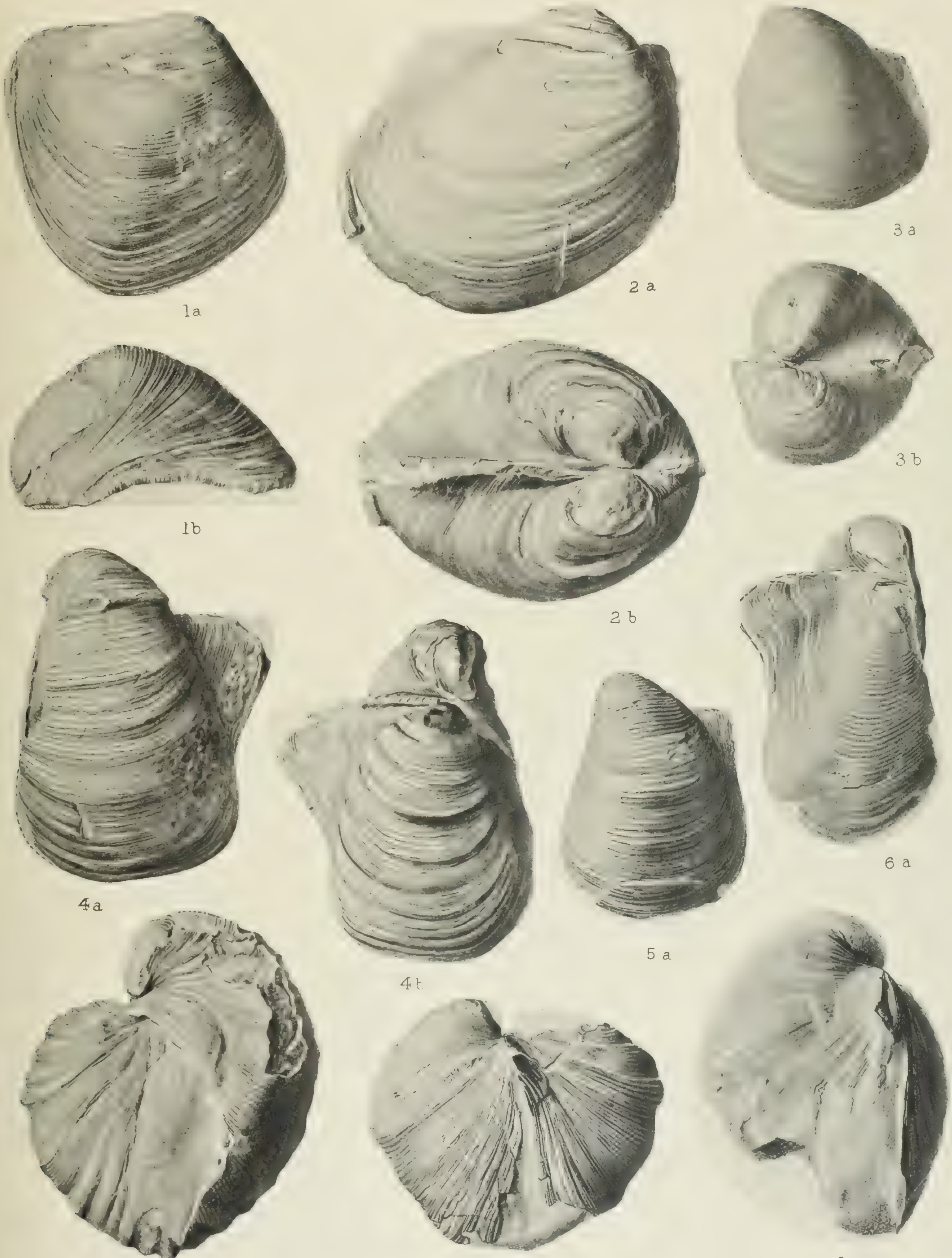
Figs.

1. *I. inconstans* var. *striatus*, Mant. Upper Chalk, Norfolk (probably zone of *Holaster planus*, Swaffham). Norwich Museum. *a*, right valve; *b*, posterior view. (P. 292.)

2, 3. *I. inconstans* var. *sarumensis*, Woods. Zone of *Actinocamax quadratus*, East Harnham. Dr. Blackmore's Collection. 2*a*, right valve; 2*b*, dorsal view; 3*a*, left valve; 3*b*, dorsal view. (P. 293.)

4—6. *I. Lamarcki*, Park. Zone of *Holaster planus*. (P. 307.)

4. Newmarket. Sedgwick Museum, Cambridge. *a*, left valve; *b*, right valve with umbo of left valve; *c*, anterior view.
5. Stonehall pit, Dover. Collieries' Museum, Dover, No. 2134. *a*, left valve; *b*, posterior view.
6. Shakespeare's Cliff, Dover. Collieries' Museum, Dover, No. 2133. *a*, right valve with umbo of left valve; *b*, posterior view.



CRETACEOUS LAMELLIBRANCHIA.

T. A. Brock, del.

London Stereoscopic Co. Imp.

PLATE LIII.

INOCERAMUS (*continued*).

FIGS.

1, 2. *I. Lamarcki* var. *Websteri*, Mant. Upper Chalk. (P. 318.)

1. Upper part of zone of *Holaster planus*, Borstal pit. Mr. Dibley's Collection. Right valve.
2. Zone of *Micraster cor-testudinarium*, Chelsham, Surrey. British Museum, No. L2176. *a*, right valve (the anterior part concealed by flint); *b*, posterior view.

3. *I. Lamarcki*, Park. Southeram, Lewes (probably zone of *Holaster planus*). British Museum, No. 4767. The Type of *I. undulatus*, Mant. *a*, left valve; *b*, dorsal view. (P. 319.)

4—6. *I. Lamarcki* var. *apicalis*, Woods. (P. 319.)

4. Zone of *Rhynchonella Cuvieri*, Hitchin. Sedgwick Museum. *a*, right valve; *b*, anterior view.
5. Zone of *Rhynchonella Cuvieri*, Peter's pit, Burham. Mr. Dibley's Collection. Left valve.
6. Zone of *Holaster planus*, Newmarket. Sedgwick Museum. *a*, left valve; *b*, anterior view.

7. *I. Lamarcki* var. *Cuvieri*, Sow. Zone of *Terebratulina lata*, Royston. Sedgwick Museum. Right valve. (P. 320.)

8. *I. cordiformis*, Sow. Zone of *Micraster cor-anguinum*, Gravesend. British Museum, No. 43277. The Type. *a*, left valve; *b*, dorsal view of both valves. (P. 334.)

CRETACEOUS LAMELLIBRANCHIA.

T. A. Brock, del.

London Stereoscopic Co. Imp.

PLATE LIV.

Inoceramus (*continued*).

Figs.

1. *I. Lamarcki*, Park., *var*. Swaffham, Norfolk (probably zone of *Holaster planus*). Variety connecting *I. Lamarcki* with *I. cordiformis*. Norwich Museum, No. 3298. *a*, right valve; *b*, anterior view. (P. 335.)

2—4. *I. cordiformis*, Sow. Upper Chalk. (P. 334.)

2. Zone of *Micraster cor-anguinum*, Gravesend. Sedgwick Museum. Right valve.

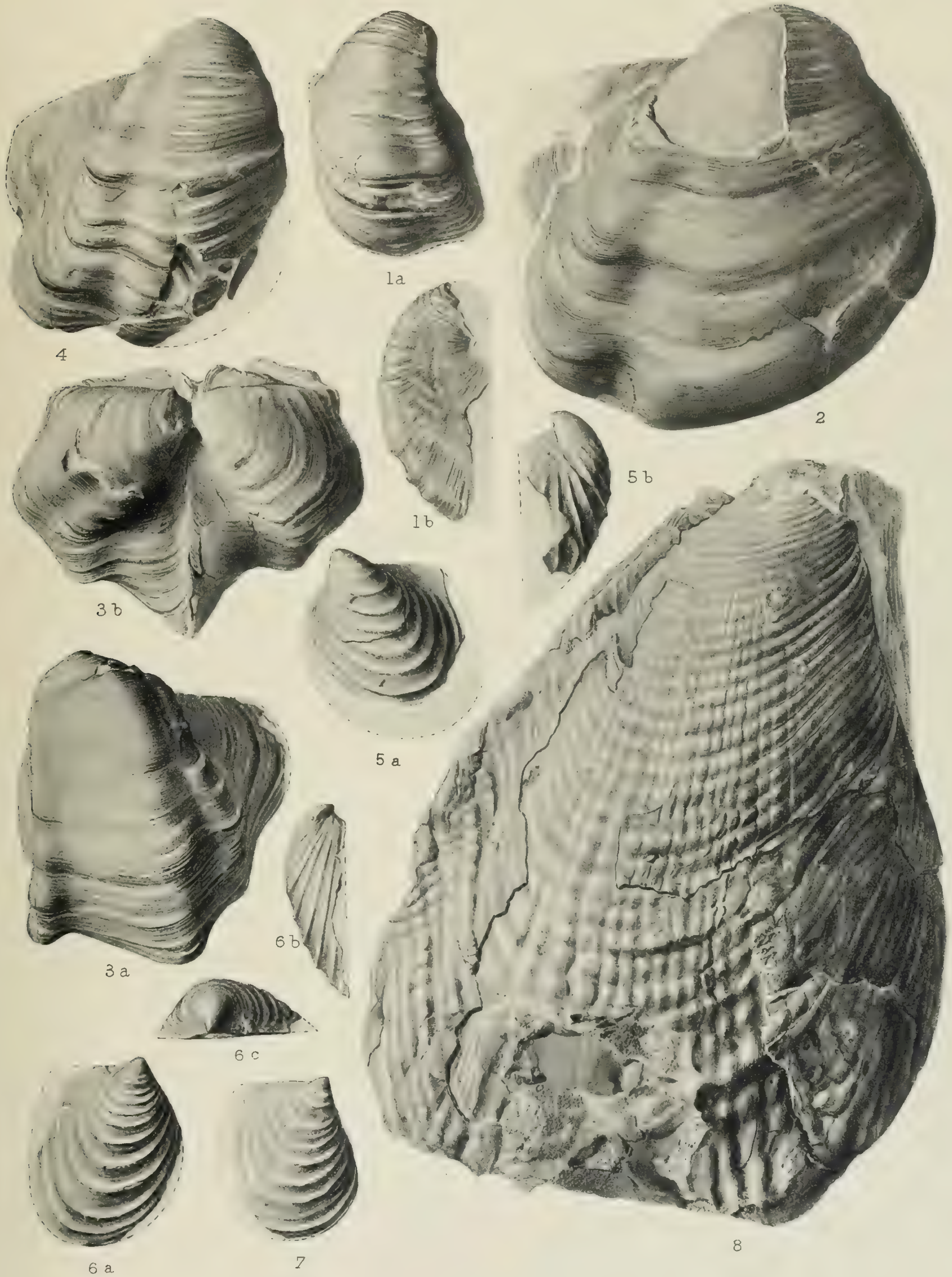
3, 4. Same zone, Micheldever. Dr. Blackmore's Collection. 3*a*, left valve; 3*b*, dorsal view of both valves; 4, right valve.

5—7. *I. costellatus*, Woods. Chalk Rock. (P. 336.)

5. Cuckhamsley. Sedgwick Museum. *a*, left valve; *b*, anterior view.

6, 7. Blount's Farm, Marlow. Museum of Practical Geology, Nos. 25510, 25511. 6*a*, right valve; 6*b*, anterior view; 6*c*, dorsal view; 7, right valve.

8. *I. tuberculatus*, Woods. Upper Chalk (zone of *Actinocamax quadratus*), Brighton. Brighton Museum. Part of right valve. (P. 302.)



CRETACEOUS LAMELLIBRANCHIA.

.A.Brock, del. London Stereoscopic Co. Imp.

THE

PALÆONTOGRAPHICAL SOCIETY.

INSTITUTED MDCCCXLVII.

VOLUME FOR 1911.

LONDON:

MDCCCCXII.

MONOGRAPH OF THE BRITISH FOSSIL SPONGES.

ORDER OF BINDING AND DATES OF PUBLICATION OF VOL. I.

PAGES	PLATES	ISSUED IN VOL. FOR YEAR	PUBLISHED
Title-page and Index (255–264)	—	1911	February, 1912
1—92	I—VIII	1886	March, 1887
93—188	IX	1887	January, 1888
189—254	X—XIX	1893	December, 1893

A MONOGRAPH

OF THE

BRITISH
FOSSIL SPONGES.

VOL. I.

SPONGES OF PALÆOZOIC AND JURASSIC STRATA.

BY

GEORGE JENNINGS HINDE, Ph.D., F.R.S.

LONDON:
PRINTED FOR THE PALÆONTOGRAPHICAL SOCIETY.
1887—1912.

PRINTED BY ADLARD AND SON, LONDON AND DORKING.

INDEX TO VOLUME I.

Note.—The plate-numbers are given in large Roman numerals, and the numbers of the figures in small Roman numerals. The numerals in **black type** indicate the page on which the diagnosis occurs.

ERRATA.

P. 100, second line from bottom, *integrated*, should read *disintegrated*.
P. 228, second line from top, *Brit.*, should read *Cat.*

ADLARD AND SON, IMPR., LONDON AND DORKING.